THE BOTANICAL FEATURES

OF THE

South-Western Cape Province

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THE

Botanical Features

OF THE

South Western Cape Province.

Essays by

R. S. ADAMSON, M.A., *Harry Bolus Professor of Botany, University of Cape Town.*

R. H. COMPTON, M.A., *Harold Pearson Professor of Botany, University of Cape Town; Director of the National Botanic Gardens.*

P. A. VAN DER BYL, M.A., D.Sc., *Professor of Plant Pathology and Mycology,* and *Acting Principal of the College of Agriculture, University of Stellenbosch.*

MISS E. L. STEPHENS, B.A., *Senior Lecturer in Botany, University of Cape Town.*

MRS. M. R. LEVYNS, B.A., *Lecturer in Botany, University of Cape Town.*

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INTRODUCTION.

R. S. ADAMSON.

THE SKETCHES here included have been drawn up with a view to providing a short introductory guide to some of the botanical features of the south-western portion of South Africa. While the original intention was to provide some notes that might be useful to botanists visiting this country on the occasion of the visit of the British Association for the Advancement of Science, it is hoped that the information may be of use also to others.

The accounts make no attempt at completeness or finality. Only the most general features are dealt with and details have been excluded as far as is compatible with clarity.

The historical aspects of botanical study and exploration in South Africa have not been mentioned. An account with a bibliography is included in the handbook "Science in South Africa" which, though published in 1905, is still generally available. Further references and much useful information on this and other aspects will be found in the pamphlet issued by the Botanical Survey of South Africa (No. 4, 1922).

The information contained in these sketches refers, with few exceptions, to a quite limited area which extends about 100-150 miles from Cape Town. This area may be taken as bounded by Swellendam on the east, Matjesfontein on the north-east, and by Clanwilliam on the north. Unless specially noted, information and data apply only to this limited region and are not always of general applicability beyond its bounds.

Physical Features.

Some account of the physical and topographical features is essential to the understanding of the vegetation and the flora. At present, only the most general features will be touched upon. A fuller account with maps can be found in the handbook issued by the Union Castle Mail Steamship Company.

The geology of South Africa has recently been treated by Du Toit in a volume issued in 1926 and will not be mentioned here at all. While the vegetation often shows remarkable correlations with geological age or other features of the rocks, these are matters of local rather than general importance.

The south-western portion of the Cape Province is a region of varied topography. In very general terms, there is an elevated inland region, the Karoo, which has an altitude of 2,000-3,000 ft. This is separated from a coastal plain by mountain ranges. The main dividing ranges run north and south along the west, and east and west along the south boundary of the Karoo: that is they run parallel with the sea coast. The point of junction of these ranges is in the neighbourhood of Tulbagh. From here the main ranges extending north are the Witzenberg, Cold Bokkeveld Mountains, and Cederbergen; extending eastward are the Waaihoek and Hex River Mountains, and Langebergen. A further mountain system runs south from the main junction point extending to the sea. This is made up of the Wellington Mountains, Drakenstein Mountains, and Hottentots Holland Mountains with subsidiary ranges. The mountains may rise to a height of 7,000 ft. or more. The ranges are most often steep, sharp and narrow. Table Mountain with its extensive top is by no means typical of the South Western mountains.

The main dividing ranges are 30-90 miles from the coast. The so-called ranges are frequently complex systems of mountains. For example, in the eastern part of our area the Langebergen form the main divide. Running parallel to theses on the south are the River Zondereinde Mountains with a broad broken valley between. On the north are the Witteberg and further east the Klein Zwartberg which separate the Western Karoo from the intervening less elevated region of the Little Karoo (1,200-2,000 ft.).

The mountain ranges are formed from the harder rocks, principally quartzites and hard sandstones; the softer rocks form the valleys and the intervening plateaux.

This region with elevated mountains quite near the coast has not any very extensive river systems. It may be mentioned that the three principal streams take their origin in or near the junction point of the three mountain systems. Further, at the earlier part of their course, these rivers run parallel to the coast; the Berg River and Oliphants River which enter the sea on the west commence by running northwards, while the Breede River which runs out on the south coast flows eastwards for a long distance.

The main rivers run in flat-bottomed valleys usually with considerable alluvial deposits; meanders are common. The mountain streams which act as feeders run in deep rocky gorges.

The drainage of the Karoo and Little Karoo is often by streams that cut through the dividing ranges. Examples are seen in Mitchell's Pass and Kogman's Kloof. Many others occur outside our area.

Climate.

In general terms the region has a warm temperate climate with a winter rainfall and a dry or relatively dry summer.

The topography of the country has a very marked influence on the climate and especially on the rainfall. The moisture carried by the winds coming from the ocean is caught by the higher mountains and hence a division into two sharply differentiated portions is caused. The coastal belt, including the mountains receives a regular winter rainfall while the part inland from the dividing ranges is arid with a small and uncertain precipitation. These two regions may be referred to as the coastal belt or South Western region proper and the Karoo. The latter includes the Little Karoo.

Rainfall.

The total annual rainfall shows considerable variation in different parts. The precipitation on the mountains is heavy, possibly up to 100 inches, but the amount decreases rapidly on the plains. The Karoo region may have as little as 5 inches.

Reliable information on rainfall for the unoccupied districts and mountains is not obtainable, but the following table will give some idea of the range at the lower levels. The figures are averages of a variable number of years from 30 to as little as 3. The winter period in the fourth column is taken as the six months May to October.

Station.	*Alt. ft.*	*Ann. Rain in.*	*No. of rainy days.*	*% of rain in winter.*	*Remarks.*
Table Mountain	3582	77·68		75	
Cape Town	88	25·01	92	78	
WEST COAST PLAIN.					
Malmesbury	353	18·02		78	
Saldanha Bay	15	11·56	90		
Graafwater	582	11·99	65		
Clanwilliam	245	8·53	49		
Algeria	1500	25·96	63		in valley below dividing range.
Cederberg	4700	35·57	66		on main range.
CENTRAL PLAIN.					
Raapenberg	50	28·03	111		near mountains.
Bellville	231	18·13	63		
Kraaifontein	345	24·93	88		
Paarl	450	33·61	71	79	
SOUTH COAST PLAIN.					
Somerset West	100	25·76	63	65	
Houwhoek	960	22·93	62		
Caledon	760	21·32	87	66	
Swellendam	500	31·51	87	58	close under mountains.
MOUNTAIN STATIONS.					
Bains Kloof	1950	64·27			Pass on first range.
Steenbras	1450	38·26			lower part of Hottentot's Holland.
Elgin (plantations)	900	41·89	88		
Viljoen's Pass	1000	58·51	106		based on 2 years.

STATIONS NORTH OF FIRST RANGE.

Station	*Alt. ft.*	*Ann. Rain in.*	*No. of rainy days.*	*% of rain in winter.*	*Remarks.*
Worcester	780	12·38	37	74	
Onder Noree		7·22	23		
Robertson	600	12·56	54	62	
Ceres	1493	41·52	67	77	close under mountains.
		LITTLE KAROO.			
Montagu	730	12·9	33	66	close to mts.
Barrydale		5·72	10		based on 3 yrs.
		WESTERN KAROO.			
Touws River	2500	9·16	33	68	
Matjesfontein	2970	6·85	25	63	
Laingsburg	2160	4·57	18		

At higher altitudes on the mountains the rainfall is certainly much greater. The figure for Table Mountain, 77·68 inches gives some indication of this. Table Mountain is an isolated summit of less elevation than most of the ranges and has less cloud cover in winter so that the assumption seems justified of precipitation of 80-100 inches per annum on the higher ranges.

The figures given in the table cannot be regarded as providing anything but a very much generalised picture. Over the whole country the rainfall shows considerable fluctuations from year to year. This irregularity is especially marked in the drier regions where the annual average is by no means the amount that can be expected. Even in the moister regions near the coast this irregularity is considerable as the following figures will show:—

Station.	*Average.*	*No. of years.*	*Max.*	*Min.*
Table Mountain	64·61	32	87·53	46·92
Cape Town Reservoir	33·09	38	47·17	21·72
Steenbras	38·26	13	50·05	19·51

In the mountain regions especially, the amount of rain per annum varies very considerably, even in a very small area. The following figures for Cape Town area will illustrate this:—

West Side of Mountain.	*Rainfall ins.*	*Alt. ft.*	*No. of Yrs.*
Green Point	19·40	20	10
Sea Point	22·85	43	26
Camps Bay	24·25	100	18
North Side of Mountain.			
Cape Town Fire Station	25·01	88	64
Cape Town Molteno Reservoir	33·09	306	38
East Side of Mountain.			
Royal Observatory	25·28	40	85
Newlands Reservoir	60·62	450	6
Kirstenbosch	57·38	300	15
Table Mountain.			
Woodhead Dam	64·61	2413	32
McLear's Beacon	77·68	3582	18
Kloof Nek	27·42	700	3

Another feature may be mentioned. The number of rainy days is less in the drier regions, where storms are a usual form of precipitation.

Of the total precipitation by no means all is effective: loss through evaporation and run-off is very considerable and especially so with rainstorms and summer falls.

Snow.

Snow is confined to the higher mountains where it falls practically every year. Near the coast snow does not often occur below 3,500 ft. and even above this does not remain for long. In the higher mountains, however, snow may persist for some weeks.

Wind.

In addition to the usual effects on the coast and on the mountains, the climate here is influenced to a large extent by the South-East winds that are prevalent in summer. They bring up mists that settle on the mountains. These winds have been shown to provide a considerable amount of moisture by deposition on vegetation as well as reducing the rate of evaporation. The upper parts of the mountains may frequently have this moisture-saturated atmosphere even while the valleys are exposed to conditions of very rapid evaporation.

The mists brought by the south-east winds are especially prevalent near the coasts but the mountains further inland are also influenced by them.

Temperature.

While the whole region is a warm temperate one, the ranges of temperature and maxima and minima show a large amount of variation. Near the coast there is an oceanic type of climate with relatively small range of temperature while further inland much more continental conditions prevail. This is especially pronounced on the Karoo Plateau where the annual and daily range is large.

The difference renders monthly or annual average figures of little value. As an example the following may be quoted:—

	Average Monthly Temp °F.		*Average Daily Range °F.*	
	May-Oct.	Nov.-Apr.	May-Oct.	Nov.-Apr.
Cape Town	54·2-60·2	61·7-69·2	8·6-15·7	10·8-12·7
Ceres	48·0-58·2	59·2-69·1	25·8-29·1	26·0-29·4
Worcester	52·1-61·4	63·3-72·1	23·1-30·0	24·7-29·1

Frosts are unknown at the coast but of common occurrence at night at inland stations and at the higher altitudes.

Radiation is an important factor which has a considerable influence locally on the vegetation. It is specially of importance in the drier regions and at high altitudes.

Humidity.

Little information is available on the relative humidity. The general range of fluctuations corresponds to those of temperature. Low values are frequent in summer except at high altitudes. On the Karoo very low values may occur at any time.

Soils.

In this region the rocks are practically all siliceous. No limestones of any importance occur and except for granite, rocks of igneous origin are absent. The soils fall generally into two main types, sands which are often very coarse grained, and finer almost clay-like soils.

Practically no work has been done on the soils from the developmental standpoint. As would be expected in a mountainous country, the majority of the soils are immature. Even the low grounds are often covered with drift sand or recent alluvium. Where these are not present the more level areas in the coastal belt have a soil of the "Brown Earth" type. These have a more or less distinct concretionary layer in the subsoil, 2-4 ft. below the surface. The soils are generally rather pale in colour though a definite dark humus layer may occur on the surface.

Black soils occur locally on the plains which have been regarded as of swamp origin. On the mountains where level and stable soils are present, a highly leached sand with a superficial layer of humus occurs. These soils approach the features of "Podsols" in many ways. On the Karoo soils of the desert type are found.

Especially at the lower levels and in the drier regions most of the soils are rather poor in humus. Humus-rich soils occur at high altitudes, in forests and swamps. The reactions of the soils vary: those of the mountains, including the forests in the kloofs, are distinctly acid. The finer grained soils are neutral or even alkaline. Low-lying areas which are water-logged in winter are often strongly alkaline (brack) owing to the deposition of salts on evaporation. The Karoo soils are neutral or alkaline.

Vegetation of the South-Western Region.

R. S. ADAMSON.

As a sharply marked geographical type of vegetation, probably few regions are better known than the south-western Cape.

The general features are described and compared or contrasted with other regions in all the text books on geographical distribution. But while the features of the vegetation as a whole are thus well known, very little information is available in regard to the communities composing it or of the relations to the surroundings or to one another.

This lack of information can be traced to two main causes: the geographical situation, and, more importantly, the characters of the vegetation itself. Not only is the flora an exceedingly rich one as regards numbers of species, but throughout there is a decided uniformity of type as regards life-form and leaf size.

In few of the communities is there any definite dominant species or group of species. Further, large numbers of the species have limited geographical ranges, and communities on similar habitats in different parts are often found to have very different populations.

Three main types of community can be recognised, bush, forest, and marsh or swamp (vleis). Of these the first is very much the most widespread and constitutes what is regarded as the typical vegetation of the region.

BUSH.

This bush comprises large numbers of distinct communities but throughout there is a characteristic form and structure. Xerophytic shrubs or undershrubs with small hard evergreen leaves almost always predominate. The ericoid type of leaf is especially common and is found in a large number of plants belonging to a wide range of taxonomic groups. This high percentage of shrubs with very small leaves brings about a difference in general aspect as compared with the sclerophyll vegetation in other parts of the world with which this vegetation is usually grouped. The identity of the Cape vegetation with the sclerophyll has been carried to the extent of introducing names for communities; e.g. "macchia" etc. While the similarities are undoubted there are so many differences in detail that this importation of names seems inadvisable.

The communities are rarely truly closed and there is a general absence of definitely dominant species: they have large and frequently varying populations. Plants of social habit are infrequent. Detailed examination reveals the fact that the "areal percentages" of individual species are low as are also the figures for Raunkiaer's "valency," This is found even in the study of apparently uniform communities and is not the result of habitat or other local variations. When similar communities are compared in different places, even when little separated geographically, the degree of constancy of species is often very low.

The problem of "exclusiveness" (gesellschaftstreue) has not been studied in these communities, but comparative observations would suggest that the number of exclusive, and often very locally exclusive, species is large.

In spite of these characteristics, the communities have a quite definite physiognomy, and in any one the biological spectrum is definite. Indeed the life-forms provide one of the most convenient criteria for delimitation and especially for comparison of the communities from different localities where the species populations may be very different.

These characters of life-form and leaf size are exhibited both in relation to habitat and to succession.

Communities.

These characteristics of large constituent poulations and local floristic differences render any detailed description of the communities a matter beyond the scope of a short account. The area is large and the diversity very considerable. A full description of the main types is available in Marloth's "Das Kapland" which covers the whole area, though this was written before the concept of succession had become established in plant geography. For the communities of Table Mountain an outline account has been produced more recently (Adamson, Journ. Ecol. XV., 1927).

In the present short treatment it is obviously impossible to include every habitat or local variations. All that is aimed at is to outline some of the chief characteristics on very general lines.

The communities may be conveniently separated into two groups on a topographic and climatic basis: those on the lower slopes of the mountains, the valleys, and the plains, on the one hand, and, on the other, those of the upper portions of the mountains.

The first group occupies the country with limited rainfall, 12-30 ins. per annum; the upper regions have a heavier rainfall and a moister atmosphere owing to mists both in summer and in winter.

While the line of division is an arbitrary one, it is one that is readily recognised on most of the mountain ranges. The lower slopes are usually covered by talus or other detrital material. Very often cliffs form a boundary between the lower and upper regions. The altitude of the line of separation varies; it is lower near the coast.

Communities of Lower Levels.

Within the lower region groupings of the communities can be made according to the rainfall and the type of soil. The slopes of the mountains are the portions with the higher rainfalls (20 ins. or more). While the soil is varied in character, sands or soils with a greater or less admixture of sandstone material are especially common; the sand is derived from the weathering of the rocks that form the upper regions of the mountains. On such habitats the community that is to be regarded as forming the climax is a quite characteristic one though it exhibits a very wide range in floristic composition. This is a bush community which fully developed has three or more layers though none of these layers is as a rule quite continuous. The uppermost is made up of large bushes (or even small trees) which have rather hard xerophytic leaves typically flat and of moderate size. Members of the Proteaceae are especially characteristic here.

Below and between these larger plants are smaller bushes that very often have ericoid leaves. Along with these are many other plants of many forms. Restionaceae are abundant on sandy soils where they may form a continuous layer. On the finer grained soils they are rare or absent. Some true shade species are found in these climax communities.

The soil has a distinct surface layer of humus.

With variations of aspect and rainfall, this climax type of community shows all gradations from a dense thicket of shrubs 6-8 ft. or more in height to a rather open community of low bushes (3-4 ft.). It occurs on all types of soil, sandstone, sand, scree, granite, clay, etc., though of course, the characteristic species show differences on these different soils and in different geographic localities. For example, on the Cape Peninsula alone the character plants of the uppermost layer of the climax community are exceedingly varied: on the sandy flats and lowest slopes *Protea mellifera* is the most abundant; on clay soils on slopes *Leucadendron argenteum* is locally dominant; *Protea lepidocarpodendron* is the character plant of talus slopes on the north and west sides of Table Mountain, *P. incompta* on the east; *Protea grandiflora* occurs on the shallower soils; *Leucospermum conocarpum* on soils derived from the sandstone. In the southern part of the Peninsula *Leucospermum conocarpum* and *Mimetes hartogii* occur on sandstone kopjes while on the flatter parts with deeper sandy soils *Leucadendron decorum* is present.

The associated species shows also a very large range of variation. For example lists made of climax communities on the east, west and north sides of Table Mountain contained respectively 90, 90, and 97 species of flowering plants but of these only 18 species were found in all the examples. On the other hand in all their features of structure, life-form, and leaf size the communities were very similar. These communities are from localities very close together; if comparisons were made between examples from more widely separated regions these features become still more marked.

On the plains and hills with lower rainfall, 12-20 ins., a similar but more xerophytic and less complex community forms the climax. In the drier regions the differences of soil become more striking. On sandy soils the climax is very similar to that on the mountain slopes but with lower bushes and less completeness of layering. On clay soils the communities are distinctly more xerophytic. Though these soils may become water-logged in the winter, they become very dry and often baked hard on the surface in summer. The clays have less humus. The climax community is more open and more xerophytic. The Restionaceae, so characteristic of the sands, are quite absent.

In regions of still lower rainfall, 10-12 ins., simpler types of structure are found as the climax, either ericoid-leaved or other xerophytic bushes, or, on sands, restionaceous plants with occasional bushes. Large succulent plants, *Aloe spp.*, *Euphorbia spp.*, and others, may be a conspicuous feature. These can be looked upon as cases where the full development is checked and the end phase corresponds to one that is superseded in more favourable regions.

Where the rainfall is below 10 ins., communities of a different type are developed which are outside the immediate subject in hand.

While the communities of the kinds mentioned are the end phases of development or climaxes, over most of the region they are by no means abundant. Indeed, it is not too much to say that in many parts they are decidedly rare. This rarity is due in part to instability of habitat which limits development, and in part to destruction and interference. The latter are much the more important. Destruction has resulted from the activities of agriculture and of settlement, from wood-cutting, and from grazing, but by far the most potent and wide-spread agent has been and is burning of the vegetation. This destruction has resulted in the production of simpler and more xerophytic communities. These show a complete range of structure from a very simple open one to a more complex layered condition. The plants composing these communities are usually smaller than those of the climax and have smaller leaves or more xerophytic structure.

On sandy soils communities in which restionaceous plants predominate are frequent. Any attempt at description of these communities would extend far beyond the limits of space available, and only a few points can be mentioned.

On the drift sands in the plains or by the coast the stages of development can be traced and these are found to be parallel in many features to those seen in regeneration after fire. On these moving sands the absence of efficient sand binding grasses is worthy of note. The pioneer dune-builders are shrubs which are either prostrate or branch at the base. The general line of development passes from these through xerophytic bushes, Restionaceae, ericoid bushes, to the climax.

The exact series of stages in the regeneration succession varies very much upon different types of soil, and is further complicated, and the lines of development deflected, by destruction before the climax is re-attained. The effect of frequently recurring fires is to produce communities often very different from those in the primary succession. Not only are the species different but the proportions of the life-forms is changed. Geophytes and hemicryptophytes which are more or less protected from the effects of fire, become very much more abundant. As an example, *Bobartia spathacea* may be noted; this plant becomes exceedingly abundant and sometimes almost approaches dominance on the fine grained soils after fire. It forms communities associated with Tetraria and other tufted Cyperaceae in which few shrubby plants are found. At higher altitudes some of the larger species of Tetraria, (e.g. *T. thermalis* on Table Mountain), are also exceedingly fire resistant and spread largely when competition is removed.

Such communities become apparently stabilised where fires are frequent: the advance to further stages is slow owing to the impoverishment of the soil and the strong growth of the fire-resisting species, but if not disturbed, bushes do invade successfully and gradually assert themselves.

In some cases after fire, certain species become temporarily very abundant: these may be either plants previously present in the community which survive and spread rapidly for a time, or new invaders. Among the former are *Watsonia rosea* and other species. Communities containing large numbers of Watsonias on the mountain slopes are an almost certain indicator of fire. As an invader, mention may be made of *Aspalathus astroites.* This becomes very abundant on well-drained sandy slopes at the lower altitudes. It is a large bush and one which may attain complete dominance after fire. This dominance is reached in 1-2 years and is only maintained for a year or two. The community becomes invaded by other plants, Rhus, Pelargonium, Lobostemon, etc. which after a time drive out and suppress the Aspalathus. This happens though the newcomers are of smaller size.

In regions of 12-20 ins. rainfall, and especially on clay soils, an exceedingly characteristic community is present. This is one dominated by a single species, *Elytropappus rhinocerotis*, the Rhenosterbush. This plant with its grey green shoots with cupressoid leaves, covers great stretches of country. Indeed, rhenosterbush communities are far the most abundant of any one type in this region.

All residents in the country, farmers and others, are agreed that this plant is much more abundant and widespread at the present time that it was in the past.

In practically every case the communities dominated by rhenosterbush have arisen as the result of interference with, and destruction of, the original vegetation: the chief factors have been burning and overgrazing. The rhenosterbush regenerates and spreads very rapidly from seed after fire. It is avoided by stock.

These rhenoster communities in time give place to others but the change is slow especially in the drier regions and with grazing and periodic fires an apparent stability is attained. The community becomes rapidly established on derelict arable land, and the practice followed of allowing land to lie fallow after cropping provides a source of spread for the rhenosterbush.

While rhenosterbush communities are most characteristic of clay soils and regions of rather low rainfall, they do occur elsewhere. They appear after fire on sandy soils in the drier regions. On the mountain slopes with high rainfall the plant rarely attains to real dominance and the subsequent phases of development occur more rapidly. The Cape Town area provides good examples. Rhenosterbush becomes dominant after fire on the dry soils derived from granite or slate. On the western side of Signal Hill the community is relatively pure and slow changing: while on the slopes of the mountain or of Devil's Peak where the moisture is greater, the plant hardly becomes truly dominant and is driven out after four to five years if no further fire occurs.

This community, which is very much the most extensive in this region, probably nowhere represents the original, or a truly stable vegetation.

Communities of Higher Altitudes.

The upper regions of the mountains have a climate that is very decidedly more moist; the rainfall is heavier and mists are frequent in winter and not infrequent in summer. While these mists cause practically no precipitation by the ordinary methods of measurement, experiments have shown that the vegetation, especially when tall, intercepts moisture to an extent that corresponds to a considerable rainfall.

While the floristic composition of the communities at the higher levels is very different from that of those lower down, there is a remarkable similarity in the general life-forms from sea level to the summits of the highest mountains. Notwithstanding the increased moisture the shrub or undershrub with ericoid leaves is everywhere characteristic and other xerophytic forms are also present.

The mountain communities show some differences in the distribution of life-forms: large bushes are few or absent and herbaceous or sub-herbaceous plants are more abundant. Restionaceae are especially abundant and often constitute a large part of the community.

The communities are less complex: the bushes are smaller and are often arranged in a single layer. The absence of dominants and the variety of species is quite as marked as lower down.

While there are very distinct local differences in relation to habitat, these upland communities exhibit a succession of life-forms. Development passes from open bush or herbaceous or grass like plants, to a reed-like phase with Restionaceae, then to an ericoid bush community that typically represents the climax. Local communities of simple structure are often stabilised owing to habitat limitations.

At the higher levels the soil, where stability is attained, contains much humus: this may form a definite surface layer. Bryophytes are often prominent in building up this humus layer.

On the highest parts of the mountains, exposure to wind, etc., and lack of soil are limiting factors and the communities are open. The shrubby plants are frequently prostrate and some attain the cushion habit.

FORESTS.

In the area under consideration, an absence of trees is a very striking feature. At present this treelessness is certainly greater than it was at one time. Not only did some of the upper layer of the bush communities attain tree stature but true forests, which are now confined to the deepest and most sheltered kloofs on the mountains, once extended much further over the slopes.

The forests here represent outliers of the vegetation that becomes fully developed on the central part of the south coast, in the Knysna-Humansdorp region, where the rainfall is distributed through the year. In the winter rainfall area forests only occur where the summer drought is mitigated by permanent streams or deep shady kloofs.

At the present time in this region forests are more abundant in the mountain kloofs. Along rivers they have been reduced in most cases to little more than a fringe of trees.

The forest communities differ in so many ways from the bush communities that it is difficult to regard them as genetically related. The life-form is different and the leaf both in size and character. Instead of the dull, small, often ericoid leaves of the sclerophylls, the forest trees have laurel-like leaves with a polished surface.

When fully developed the forest is a rather complex community: the main canopy is made up of a number of species that occur in association. The exterior is irregular not smooth. Below these are smaller trees which may form a continuous layer. Shrubs do not form a complete layer. Lianes, though not numerous in species, often form a distinct feature, festooning the larger trees. Epiphytes, mainly ferns, occur but are not numerous. The ground plants show great variation with conditions, ferns are abundant. Not infrequently, lack of light limits the amount very much.

Several communities of forest are recognisable, depending on local conditions of soil, moisture, and other factors. The structure and appearance of all are, however, very similar. These have been described for the Knysna forests and need not be repeated in detail. It will be enough to mention that *Cunonia capensis* is especially abundant where soil water is permanent; *Podocarpus latifolius, Olea laurifolia, O. capensis* and others in moïst but less wet situations, *Ocotea bullata* and *Curtisia faginea*, the trees with the largest and least xerophytic leaves, occur here; in drier parts are *Cassine capensis, Olinia cymosa* and *Olea ver-*

rucosa. Podocarpus elongatus and *Brabejum stellatifolium* often form forest zones along rivers.

The forest with its trees with laurel-like leaves is the climax of a developmental series. Several of the earlier stages can be recognised. These comprise communities of both trees and of bushes. These communities are found as zones around the margins of forests, in clearings and in openings in the forest itself, and also in stations in which forest at one time existed. Some of these are closely allied to the climax while others are very different both in structure and in composition.

Those stages that appear nearest to the climax are communities of the more xerophytic trees of the forest such as *Cassine capensis*, *Olea verrucosa* and others. These form less dense woods in which lianes, epiphytes, and the more hygrophytic elements of the undergrowth are wanting. Along streams are found communities in which *Brachylaena neriifolia* is the chief constituent: these are also communities of the same rank.

Communities further removed from the climax are those composed of trees with small leaves which cast a much less degree of shade: *Virgilia capensis* is the commonest and the most important example. It is worthy of note that the deciduous *Salix capensis* occurs in riverside communities of this kind.

The communities of bushes are exceedingly varied in composition in different localities, and a very few of the principal constituents are all that can be mentioned. The bushes are as a rule of rather large size and most of them are not strikingly xerophytic. Instead of the hard small leaf of the sclerophylls many have soft leaves of moderate size:— *Cluytia pulchella*, *Polygala myrtifolia*, *Podalyria calyptrata*, *Gymnosporia buxifolia* and others: others are more xerophytic in leaf-form, as *Metrosideros angustifolia*, *Phylica buxifolia*, and *Widdringtonia cupressoides*: a few have the laurel-like leaf of the forest trees, such as *Botryceras laurina* and *Cussonia thyrsiflora.*

The number of species in these communities is very large but with few exceptions they are less xerophytic in form than those of the sclerophyll communities. Some species, though not very many, do occur in both types. These are the more mesophytic of the sclerophylls, such as *Oftia jasminum*, *Pelargonium cucullatum*, *Osteospermum moniliferum* and others.

Associated with the bushes are many herbaceous plants and undershrubs which often have large leaves, e.g., many species of Pelargonium, *Senecio rigidus*, *Leonotis leonurus*, and many others.

The proof that these communities do represent stages in the regeneration of forest rests for the most part on comparative evidence. The time required for the passage from one stage to the next in the succession is long. This is especially so in the more advanced stages and in the establishment of the climax. The trees composing these forests are all of slow growth and some of them very slow.

Examples, however, can be found where young forest trees are becoming established under Virgilia or under bushes. Such examples taken along with the evidence obtained from geographical, topographical, and other sources leaves no serious doubt on the question.

The life-form, floristic composition, and habitats of the forest are distinct from those of the sclerophyll communities. They are best looked upon as constituting portions of a vegetation type dependent on a more equably moist climate.

It may be mentioned that forests are absent even in kloofs in mountain ranges in regions of low rainfall. None occur with less than 25-30 ins.

The laurel-like leaves, the presence of lianes and epiphytes, and the rather hygrophytic undergrowth, completely separate these forests from the sclerophyll forests of Europe, America, or Australia.

MARSHES AND VLEIS.

The fresh water aquatic flora and vegetation is dealt with in a separate chapter and little need be said of marsh vegetation. The general characters are exceedingly uniform everywhere: reed-swamps, passing to marshes largely dominated by Cyperaceae and so forth, occur here at the margins of permanent fresh water.

In this country, with its long dry season, many areas which are under water for the winter and spring, become completely dried up in the summer. In such places the typical swamp vegetation is lacking. The true aquatic plants become dormant and the exposed ground is covered with small plants which are annuals or truly amphibious perennials. In many cases on drying, considerable quantities of salts are deposited and even at long distances from the sea there occur plants which suggest maritime conditions: e.g. Salicornia, Frankenia, Statice, etc.

Among the fresh water communities, one may be given special mention, a community dominated by *Prionium serratum*, the " Palmiet." This plant occurs in and along slow-flowing rivers or streams. With its branching stems each bearing a tuft of leaves, the plant forms almost pure communities which extend from the bank into or even across rivers. The community is a pioneer one, though from its habit and habitat, it may persist for long periods. As soil is accumulated the palmiet becomes invaded and finally driven out by tall reed-like plants. Among these *Elegia verticillaris* and *Leptocarpus paniculatus* are abundant. Later bushes or small trees appear, such as *Psoralea pinnata*, *P. aphylla*, *Metrosideros angustifolia*, *Salix capensis* and others. The ultimate phase would probably in time be forest.

Salt marshes occur at various points along the coasts. Those around Table Bay, the only accessible ones within this area, have been interfered with by drainage, planting and other causes. At present little more than the outer zonation and some of the driest communities can be made out. The areas, though of much floristic interest, are not instructive from a vegetational standpoint.

CHANGES IN VEGETATION.

Some of the outstanding features of the native vegetation have been outlined shortly, and the communities that represent the climax on the different habitats have been noticed.

In a country, relatively recently affected by European civilisation and thinly populated, it might be expected that the vegetation would be in its primaeval state. In the south-western Cape this is far from being the case. Practically everywhere the plant cover shows signs of alteration and change from its original form.

As a cause of this change, fire has been much the most important and widespread factor. The vegetation, and especially that on the mountains, is burned at frequent intervals. This practice has continued from the time of the arrival of the European, and probably was carried on on a small scale by the Hottentots before that time.

In spite of legal penalties and the obviously detrimental results, no diminution of fire damage is observable.

In the mountain regions the extent of burning is such that only small scraps here and there can be found where escape has been long enough to allow development of the vegetation to continue to its full or nearly so. The persistent burning has had a pronounced effect on the plant communities. Humus is destroyed and in many cases the whole soil is washed away. Those communities that exist are much simpler in structure and more xerophytic. The plants are small and often the community is quite open. Regeneration of course takes place but when, as often happens, fires follow one another at short intervals the bad effects are increased. After each fire in an area the time for regeneration is extended.

The plants existing on frequently burned parts are those that make little demand for soil or humus. At the higher levels especially, the shrubs suffer most, and after fires the proportion of geophytes and tufted plants which are partially protected, increases.

Erosion of soil is most marked in the regions of heaviest rainfall, and here, as the result of fires, the vegetation is most sparse and poor where exactly the reverse might have been expected.

The general result on the communities of burning is a simplification and impoverishment in variety. The case of the rhenosterbush has already been noticed. It is just an extreme and widespread example of a general trend of change.

As compared with fire the other agents of change have a small and local action. The introduction of alien trees has brought about very marked changes in the communities locally. Pines, and still more Australian species of Acacia, have attained complete dominance over the native flora in places. Another Australian genus, Hakea, is locally ousting the indigenous bush. But in most cases aliens have had little influence except in the immediate vicinity of settlements.

Grazing is a factor which has not been of very much importance in changing the vegetation in the south-west. The intensity of grazing on vegetation of this kind is necessarily not great. Improvement of feeding grounds is brought forward in justification of burning, but the fire is the destructive agent not the animals.

On the Karoo, however, overgrazing has had a big influence in places. The slow growing plants are destroyed completely and where the concentration of sheep is considerable the trampled ground is unfavourable to any regeneration. Large areas in the neighbourhood of watering places, farms, etc., have become deserts or merely support open communities of the " kraalbos," *Galenia africana*.

In the south-western Cape the extent to which the natural vegetation has been altered in the comparatively short period during which European occupation has lasted is remarkable. The ultimate condition cannot be fully estimated as yet, but that stabilisation of some simpler and less diversified type of community will be reached seems most probable. Along with this, as a necessary corollary, it seems certain that many of the peculiar features of the vegetation and of the flora will disappear unless some steps are taken to check the destructive forces.

The Systematic Elements of the South-Western Vegetation.

M. R. LEVYNS.

It is generally acknowledged that the south-western coastal belt has a peculiar and characteristic flora, showing but scant relationships with the other South African floras. In some respects, however, the statement must be qualified. The region towards its eastern end is covered in places by true forest, the systematic elements of which bear hardly any relation to those of typical south-western scrub. The forests in the mountain ravines in the more westerly parts of the area are merely extensions of these eastern forests and must be regarded systematically as well as ecologically apart from the rest of the flora. Outstanding plants in these forest communities are various species of Podocarpus (yellow woods), and Olea (ironwoods), several members of the Celastraceae, *Curtisia faginea*, *Ocotea bullata* (stinkwood), *Cunonia capensis* (rooi els), *Olinia cymosa* (hardepeer), and *Ilex mitis* (Cape holly).

Neglecting these forest areas, the remaining vegetation, though far from uniform, is characterised by certain families which afford a clear indication of this particular flora. Outstanding amongst these are the families Proteaceae and Restionaceae. Both of these are best developed on sandy soils and in many such places are the most conspicuous and abundant plants in the community. Other families which occupy an important place in this flora but which are absent or rather rare in most floras of the northern hemisphere are Rutaceae, Selagineae, Peneaceae, and Bruniaceae. The two latter families are endemic. Ericaceae, Iridaceae, Aizoaceae, Thymeleaceae, and Orchidaceae occupy a more prominent position in this flora than in most others. On the other hand certain groups and families are poorly represented. With the exception of the two genera Podocarpus and Widdringtonia, the area is without Gymnosperms. Salix is the only representative of the catkin-bearing families, while such large and widely distributed families as Rubiaceae and Umbelliferae occupy a lowly position and are represented to a large extent by atypical members.

The seasons are not as clearly defined as they are in the cold temperate regions of the northern hemisphere. In the western portion of the area there is no period of complete vegetative inactivity, the nearest approach to this occurring about April just before the advent of the rainy season. With the first rains numerous Oxalis appear together with a few other plants such as *Crassula septas*. The season of greatest activity is the spring, lasting roughly from the beginning of September to the end of October.

The nature of the soil has a profound influence on the vegetation. Taking the south-western coastal belt as a whole, sandy soils predominate, and on these, what is regarded as typical south-western scrub is developed. Where, however, fine grained soils occur, the proteaceous, restionaceous and other so-called typical south-western elements become rather less conspicuous, and large areas are occupied by a type of vegetation in which the family Compositae is more than usually abundant. Rhenosterveld is the outstanding example of this. Fertile tracts of country lying to the north-east of Ceres and large areas between Caledon and Riversdale, as well as many others, are dominated by the useless grey-green shrub *Elytropappus Rhinocerotis* popularly known as the Rhenoster bush. Recent experiments have indicated that rhenosterveld is not a natural type of plant community but owes its present wide distribution to man's disturbance of natural conditions, veld burning being the chief cause of its spread.

Taking the Cape Peninsula as an example of the whole area, it is possible to illustrate the principal features of the south-western flora, and the following account therefore refers to the Cape Peninsula unless otherwise stated. If rhenosterveld which is well developed on the slopes of Signal Hill be excepted, one of the most striking features of the vegetation is the great mixture and large number of species. Only occasionally does any one species become completely dominant. An interesting point is that most of the species which have shown a tendency to behave as dominants are aliens, notable examples being some of the Australian Acacias on the Cape Flats, e.g. *A. saligna* and *A. cyclopis* and certain species of Hakea. From the flats and low lying ground to the tops of the mountains, with few exceptions, the same mixed type of plant population prevails. Species change but the general composition of the flora does not.

In a recent census of the plant population on the Peninsula, which may be taken as having an area a little over 200 sq. miles, the total number of species (excluding the Pteridophyta but including aliens) was 2,464. Of this number 743 were Monocotyledons, a high proportion when compared with other floras. Annuals are rather rare and so are trees. Geophytes are unusually abundant. Grasses at first sight appears to be poorly represented but in actual fact there are 55 genera and 133 species. However, very few of them have a social habit and the deficiency lies chiefly in numbers of individuals and not in numbers of species.

Geophytes, which are admirably suited to the rather trying climatic conditions, show many features of interest. Most of them, of course, are Monocotyledons, but a surprisingly large number are Dicotyledons. Amongst the latter are 33 species of Oxalis, a group of Pelargoniums, a small number of Crassulas and some Cyphias and Othonnas. Many of the most showy members of the flora belong to the geophytic Monocotyledons, such as various members of Iridaceae, Liliaceae and Orchidaceae, etc. In all the cases investigated members of this class of plant grow most vigorously the season immediately following a veld fire. In fact, certain of them such as *Cyrtanthus angustifolius* and *Buphane ciliaris*, both members of the Amaryllidaceae, rarely flower until the veld is burned. Another interesting feature of these plants is that in several cases the leaves, which always appear during the rainy winter months, die down before the flowers appear. This is well seen in different plants such as *Amaryllis belladonna*, *Haemanthus coccineus*, species of Eriospermum and a few others.

Many families which have a wide distribution and are well-known in Europe show certain peculiarities in this flora. The Compositae which in most countries are represented by plants almost exclusively herbaceous in habit, here show a marked predominance of shrubs, many of them of the ericoid type. One peculiar genus, Corymbium, has the general appearance of a Monocotyledon and in addition possesses one-flowered capitula. The genus Oedera at first sight appears to possess a normal capitulum but on closer investigation the capitulum is found to be compound, a phenomenon more frequently encountered in the Australian flora than in this. The large section of the family to which Helichrysum and Helipterum belong is well-developed in this flora and is characterised by conspicuous, scarious involucral bracts. The Ericaceae show an astonishing range of floral differentiation within certain circumscribed limits. Erica, with 99 species on the Peninsula alone, many of them very restricted in their distribution, is a study in itself. The Umbelliferae have several peculiar representatives. The genera Hydrocotyle and Centella are of frequent occurrence and a dioecious plant *Arctopus echinatus* with none of the usual vegetative characters of the family is another member. The Rosaceae are largely represented by the dioecious and apetalous genus Cliffortia, the species of which assume a variety of vegetative forms. In the Leguminosae shrubs predominate as in the Compositae. The only important genus belonging to the Rubiaceae is Anthospermum, an apetalous genus in which the species are almost exclusively dioecious. The *Cyperaceae* are well-developed though the section Caricoideae is not conspicuous. The majority of the species belong to Ficinia, Scirpus, and Tetraria. An unusual member of its family is *Prionium serratum* (palmiet) a shrubby, Juncaceous plant. It is a typical riverside plant, and though present on the Peninsula does not attain its maximum development there.

The area is rich in parasitic forms. Among the total parasites are Harveya and Hyobanche, both members of the *Scrophulariaceae*. Hydnora and Cytinus are two highly evolved parasites belonging to families which are wholly parasitic. Among the partial parasites, Thesium with 29 species on the Peninsula is most abundant. A few of the species have well-developed leaves but in most cases they are reduced.

Taken as a whole, the South African flora is unusually rich in succulent forms. In the south-western region, however, they are not as conspicuous a feature of the flora as they are in the neighbouring Karoo, though a few interesting examples are present. The genus Mesembryanthemum (in the wide sense), and most of the Crassulaceae are examples of plants with succulent leaves. *Euphorbia Caput-Medusae* and *Stapelia variegata* often associated with it, are both occasionally found near rocky outcrops on the western slopes of the Peninsula.

Taking the flora as a whole, certain striking features stand out at once. With the exception of outliers of the south-western flora which occur on many of the higher mountains to the north and east, the flora bears no obvious floristic relationship to any of the other African floras. In places, especially in the west, the boundary between this flora and the adjacent ones is extremely sharp, a fact of considerable interest. Another remarkable feature is the closeness with which the flora is correlated with the geological formation of the underlying rocks. The south-western flora is almost entirely confined to rocks of the Cape Series or older rocks. When, as in the district between Worcester and Robertson, rocks of the Karoo Series are faulted down forming an island of these more recent rocks amongst the older, the composition of the vegetation changes completely, so that floristically as well as geologically this island belongs to the Karoo which actually is separated from it by the high mountains of the Langeberg.

Australia is the only country possessing a flora which shows a definite affinity with that of the south-west Cape. The relationship is not a very close one as the two countries have no species in common and very few genera; but the characteristic and peculiar families of one region are closely paralleled in the other. The problem is one of absorbing interest and renders any suggestive hypothesis such as that of Wegener of more than usual interest to South Africa.

The Vegetation of the Karoo.

R. H. COMPTON.

It is impossible to frame a satisfactory definition of the word Karoo, either in terms of climate, soil, or vegetation. In different parts of South Africa the word Karoo is used to cover many distinct types of country. Plant geographers in South Africa have tended to adopt the term in a very wide significance, as expressing a type of vegetation: whereas in popular speech it implies chiefly dry sheep and goat country, as it did in the days of the Hottentots. The subdivision of the botanically vague " Karoo " into smaller and more accurate concepts is a matter of very great difficulty, and at present we are often at a loss to explain in terms of environment some of the most striking vegetational differences.

" Karoo " formations in the broad and popular sense occupy more than half of the area of the Cape Province and a small portion of the Orange Free State. Karoo is developed over practically the whole of the interior portions of the Cape Province, isolated from the coast by the high mountain ranges parallel thereto. These act by precipitating the moisture from the sea breezes, leaving the inland plains with only a comparatively casual rainfall. Although the coastward Karoo areas have for the most part an altitude of 1,500 to 3,000 feet, the mountain ranges which surround them form continuous barriers of 3,000 to 7,000 ft.: and there is rarely sufficient moisture left in the atmosphere after passing over these barriers to cause precipitation on the Karoo. The rainfall gradient on the lee of the mountains is extremely steep. Ceres, for example, situated in the angle of the Witzenberg and Hex River Mountains, has an annual rainfall of about 41 inches: whereas Worcester, only three or four miles from the Hex River Mountains, and on their lee-side, has only about 12 inches.

Great stretches of the interior of the Cape Province therefore have an erratic rainfall averaging from 4-12 inches annually, but frequently far below the average. For instance, at Whitehill the following figures have been recently recorded; (and in this same series of years the Koup districts have had even less):—

1923	5·38 inches
1924	2·98 ,,
1925	7·29 ,,
1926	3·27 ,,
1927	2·52 ,,
1928	3·20 ,,

Much of even this small rainfall is of very little value as far as the vegetation is concerned. Rains of less than 0·15 inch scarcely wet the ground, and though the shallow-rooting succulents may be able to take advantage of them, the more deeply-rooting shrubs are unaffected. On the other hand, heavy rains and thundershowers bring up the annual average but do not produce a proportional effect on the vegetation owing to rapidity of run-off. The "effective" rainfall is therefore only a fraction of that recorded by the rain gauge.

The aridity of the Karoo region is increased by the very rapid evaporation which takes place. The skies are normally very clear, the insolation intense, dry winds are frequent, the atmospheric humidity is very low and the elevated altitude also favours rapid evaporation. The vegetation is always sparse and the ground is freely exposed to all these drying influences. Moreover, the water table in the soil is low and except in the stream-beds, is of little or no value to plants. The streams that flow into the Karoo from the bordering mountains are apparently less in volume than those on their seaward slopes, and they disappear rapidly after reaching the Karoo. The Karoo stream-beds are dry for the greater part of the year, with the exception of occasional pools.

In recent decades, moreover, the aridity of the Karoo has been markedly increased by overstocking and its attendant evils. Many areas are approaching a completely desert condition, bad veld management having rendered them less capable of resisting periods of abnormally severe droughts than formerly.

The rainfall of the Karoo, as of the Union generally, has two origins. In the winter the prevailing westerly winds bring moisture from the Atlantic Ocean and this is precipitated along the western and southern Cape ranges as rain, snow and hail. Deep barometric depressions with correspondingly strong winds may carry the rain further eastwards, and at such times falls may take place over the Western and Little Karoos. In the Western Karoo the quantity of winter rain diminishes as one goes eastward, becoming practically nil between Laingsburg and Prince Albert. In the summer the prevailing winds blow from the Indian Ocean, and the moisture from this source is precipitated in the form of direct rains and mountain mists in the southern coastal belt. Over the Karoo, however, as over the Transvaal, Orange Free State and Natal, thunderstorms are of frequent occurence at this period, and local showers, often of great intensity, take place. The further westward one goes in the Karoo, the rarer become these summer storms, until in the Touws River and Matjesfontein district they cannot in any way be depended upon.

It is possible to draw a somewhat vague line across the Karoo, dividing districts with a preponderantly winter rainfall (on the south and west) from those with a preponderantly summer rainfall (on the north and east). Along this line, where the rainfall is most evenly distributed it is also most scanty, and districts such as the Koup (or Ghouph) are in some years practically rainless.

The prevailing types of vegetation to west and east of this zone of demarcation are markedly distinct, though they pass imperceptibly into one another. In the southern and western or winter-rainfall area, water storage is of the first importance in order to tide over the hot dry summer with its intense evaporation; while owing to the lack of surface moisture, such herbaceous plants as the Gramineae are unable to flourish in their natural growing season, the summer. Consequently we find in the west a vegetation largely composed of succulents and geophytes in which grasses are very scanty. In the northern and eastern or summer-rainfall area on the contrary, xerophilous grasses find more suitable conditions for growth, and succulents are less abundant and do not tend to dominate. The eastern Karoo is therefore practically a grassland. Small shrubs occur plentifully in the winter rainfall area, and somewhat less plentifully in the summer-rainfall area: their deep-rooting habits rendering them less directly sensitive to the season of the rainfall than are the surface-rooting grasses and succulents.

Within a radius of 200 miles of Cape Town, the Karoo areas are all of the winter-rainfall type, merging into the Koup area with occasional rains at any season. The following areas can be distinguished geographically:—

(1) The Robertson Karoo, occupying a small area in the Breede River Valley between Worcester and Swellendam.

(2) The Little Karoo, bounded by the Little and Great Zwartberg Ranges on the north and the Langeberg on the south.

(3) The Western Karoo, lying to the north of the Witteberg and the Little Zwartberg, and bounded on the north by the Komsberg; ending on the west in the Hex River Mountain massif, and passing gradually into the Koup and the Great Karoo on the east.

(4) The Doorn and Tanqua Karoo, the broad valley of the Doorn and Tanqua Rivers, between the Roggeveld escarpment and the Cederberg and Cold Bokkeveld ranges.

(5) The Roggeveld and Calvinia Karoo.

(6) The Van Rhynsdorp Karoo.

Botanically, the differences between these areas are rather floristic than ecological, the main vegetational features being somewhat uniform, though the actual specific composition of the floras varies considerably. Much more detailed work is necessary before accurate comparisons can be made. It will be best to study a single area as typical of the various " Karoos " and the Western Karoo may be selected for the purpose. To the general public it is the best known, as the main railway line from Cape Town to the interior passes through it from west to east. This route corresponds with the line of decreasing rainfall, and many of the correlated features are readily seen from the train.

THE WESTERN KAROO AS SEEN FROM THE TRAIN.

(*Main Line, Cape Town to Transvaal.*)

The first glimpse of typical Karoo country is on the left about four miles beyond Worcester, the low hills of clay-shale soil near the entrance of the Hex River Poort being dominated by shrubby Mesembryeae together with *Crassula Cotyledon* and *C. perfossa*, *Cotyledon orbiculata* and *C. paniculata*, *Euphorbia mauretanica* and other typical Karoo shrubs such as the guarri (*Euclea undulata*) and species of Lycium. On the rocky ground between De Wet and Sandhills numerous succulent plants occur such as *Aloe parvispina*, *Cotyledon orbiculata*, *Crassula perfossa* and *C. Cotyledon*: but the vegetation of the quartzite rocks is rather of the Dry-Cape-with-Succulents type and not characteristically Karoo; the mass of the vegetation being composed of species of Rhus and Heeria, *Dodonaea thunbergiana*, *Cliffortia ruscifolia*, *Chrysocoma tenuifolia*, *Euryops tenuissimus*, *Mundia spinosa*, *Olea verrucosa*, Eriocephalus spp., Rhenoster bush and Elegia sp.

The sandy drifts in the broader portions of the Hex River valley are also occupied by a "Cape" flora, with large bushes of *Dodonaea thunbergiana*, *Cliffortia ruscifolia*, two species of Leucadendron, tall Elegias, *Euryops tenuissimus*, the handsome *Lebeckia cytisoides* and a tall blue Salvia. The proximity of Karoo conditions is indicated by the occurrence of *Cotyledon Wallichii*, bushy Mesembryeae, *Chrysocoma tenuifolia* and the kraalbos (*Galenia africana*).

In the neighbourhood of De Doorns on clay-silt soils Rhenoster bush is dominant and here appears the typical thorn-bush of the dry river beds, *Acacia Karoo*, from which the village no doubt takes its name.

The magnificent Hex River Mountains on the left, culminating in Matroosberg, and the Keeromsberg and Kwadouws Berg on the right bear a Cape flora of a xerophytic type.

On leaving De Doorns the gradient becomes steep and the long climb to the Western Karoo plateau begins. The rail winds upwards over hard shale hills of the Bokkeveld formation bearing a vegetation in which the succulent element has become prominent. The rainfall is about 12 inches, and large succulents are abundant. The most striking are the boterboom (*Cotyledon paniculata*) with grotesque stout trunks and succulent deciduous leaves; *Cotyledon Wallichii* somewhat similar but with cylindrical leaves and knobby stems (where these two grow together a hybrid may often be noticed); and the milk-bush *Euphorbia mauretanica* with tall sparsely-branched pale succulent stems. Clusters of enormous bulbs (*Urginea altissima*) with slender inflorescences up to six feet high are abundant. *Aloe microstigma* with reddish leaves forms conspicuous patches on northern slopes, and the beautiful *Aloe striata* may be seen just beyond Tunnel Siding. Shrubby plants are abundant, the guarri (*Euclea undulata*) being specially noticeable, and forming small pure local groves. Other small shrubs are mainly Compositae, species of Euryops, Relhania, Pteronia, and Eriocephalus being abundant.

The succulent *Euphorbia hamata* grows at the entrance to the tunnel, and succulent and tuberous rooted Othonnas are frequent. *Hydnora africana* occurs as a parasite on *Euphorbia mauretanica*, and among bulbous plants the huge bulbs of *Buphane disticha* and the handsome *Veltheimia glauca* may be noticed. At the head of the pass the first flat-topped kopje, Tafelberg, marks the margin of the plateau, and the train circling round this at an altitude of 3,150 feet leaves the Cape mountain region and enters the Western Karoo proper.

The first few miles of the plateau consists of sandy and stony flats on which Rhenoster bush and *Chrysocoma tenuifolia* reign supreme, the association being poor in species and deficient in succulents: this poverty being characteristic of rhenoster veld wherever it occurs. At Touws River the rocky kopjes are mainly dominated by a typical karoo Mesembryanthemum association, except on their southern sides where a few Ericas, Leucadendrons, Lobostemons and other representatives of the Cape flora occur. The rainfall is about 10 inches and at this critical limit the difference in insolation on north and south sides of a kopje is sufficient to tilt the scale towards a karoo or a Cape vegetation respectively.

Beyond Touws River the plains derived from the Witteberg quartzites are covered with reddish sand with scattered stones. The vegetation is generally less than a foot in height consisting mainly of species of Eriocephalus and Pteronia, with thorny bushes of *Asparagus stipulaceus* and *Lycium roridum*. Large succulents are absent except for groups of *Cotyledon Wallichii* on rocky hillocks, and Mesembryeae are scarce except for Psilocaulons.

The line enters the Dwyka beds about six miles beyond Touws River, and a richer Karoo vegetation appears, consisting of more numerous species of shrubs and succulents.

The sharp difference between the vegetation of plains and kopjes can be well seen at many points. Three miles beyond Jandeboers, for instance, is a rocky ridge of Dwyka conglomerate on the north aspect of which occurs a fine growth of succulents, of which *Euphorbia mauretanica*, *Cotyledon Wallichii*, *Aloe microstigma* and *Crassula perfossa* are conspicuous, the last two giving the slopes a characteristic reddish tint. These large succulents are absent from the plains which have a mainly shrubby vegetation of Eriocephalus, *Galenia africana*, *Chrysocoma tenuifolia*, Pteronias, Selagos and Rhenoster bush.

In the neighbourhood of Constable, however, Witteberg quartzites are again entered and these continue to the railway summit near Pietermeintjes. On the bold rocky outcrops of these beds a dry Cape vegetation occurs, a good example of it being seen on the southern side of the line a mile beyond Constable. *Protea marginata* is the most conspicuous shrub, growing to a height of six or eight feet, and other Proteas, Leucadendrons, Restionaceae, Ericaceae, Rutaceae, Lobostemons, etc. occur. In this area, with the critical rainfall of about 12 inches the Karoo rocks bear a " Karoo " flora and the Witteberg sandstones and deep drift sand (as at Tweedside) bear a " Cape " flora.

Near Pietermeintjes the last is seen of the " Cape " flora along this route; the line enters the Karoo geological formation and the vegetation visible from the train is en-entirely of the Karoo type.

The average rainfall from the margin of the Karoo plateau at Matroosberg station to Pietermeintjes varies from

10 to 14 inches, though frequently much below these figures. Beyond Pietermeintjes, however, with falling altitude and increasing distance from the mountain barriers, the rainfall decreases rapidly and more or less evenly, until at Laingsburg the annual average is only about 4 inches. The aspect of the vegetation reflects this increasing aridity, and from Laingsburg to Prince Albert Road the plants are for the most part depressed Mesembryeae sparsely scattered over the shaly soil, with wide inter-spaces which, however, become more or less clothed with annuals after a good rain.

THE WHITEHILL AND MATJESFONTEIN AREA.

As an example of Karoo vegetation on a smaller scale the area in the neighbourhood of Whitehill and Matjesfontein may be taken. This lies at an altitude of approximately 3,000 feet. The rocks are mainly Dwyka shales and conglomerate with large lenticular quartzite inclusions. On the south, three miles from the railway, lies the Witteberg range 5,000 ft. high, composed of the quartzite rocks to which the range gives its name. On the north are the Ecca beds, a prominent outlier of which is Ngaap Kop (so called from the "Ngaap" or Trichocaulon spp. formerely abundant on its slopes) opposite Whitehill: on the lower slopes of this hill can be seen the "white band" of gypsum shale, marking the border-line of the Ecca and Dwyka formations. The Dwyka conglomerate weathers into a greyish or reddish soil, usually very shallow. Rocky outcrops are frequent, these having the characteristic "pillow" or "tombstone" appearance. Some parts of the area possess a deeper fine reddish soil with comparatively few stones. Other parts, derived from large quartzite inclusions, weather to a coarser sandy soil thickly strewn with stones. The Baviaans River flows in a shallow bed in its own alluvium, which is a fine yellowish silt several feet deep. The river itself only contains water for a short time after rains, except in a few pools. Several streams rising in the Witteberg, discharge storm water into the Baviaans River.

The different types of soil bear different plant associations, made up of different species, and such factors as aspect have also a conspicuous effect on the vegetation. The impression given by the vegetation at first is one of monotony, but this yields to a closer study. In reality the flora is a rich one, and there is present a great variety of shrubby plants, succulents, bulbous and tuberous plants, annuals, grasses and even ferns. The tendency to uniformity in the aspect of the shrubs, on which the physiognomy of the vegetation largely depends, is due to the heavy grazing to which the area is subjected. This factor, combined with the trampling of the soil between the bushes and root competition tend to the characteristic "hottentot's head" appearance of the country.

The Raunkiaer Percentage Spectrum of the flora of the Karoo at Whitehill, based on 275 species of flowering plants collected there, is as follows:—

S	E	MM	M	N	Ch	H	G	HH	Th	
29	0	1	1	34	2	7	15	0	11	= 100

Compared with the "normal spectrum" one notes the very high percentage of succulents, small woody plants and geophytes, that is of the "xerophilous" elements: the luxuriant and herbaceous types, namely large woody plants, chamaephytes and hemicryptophytes, being markedly deficient.

River Bed Vegetation.

The river runs for a few days only after heavy rains in its catchment area. Small semi-stagnant pools may remain for a considerable period, however, and these support an algal vegetation, while their muddy margins are occupied by a dense mat of such plants as *Juncellus laevigatus* and *Cotula coronopifolia*. The stream cuts its way through deep fine-grained alluvium, and at the foot of the banks grow tufts of *Scirpus dioicus*, associated with *Mentha longifolia*, *Lobelia thermalis*, etc. At the crests of the banks occurs a well-marked zone of the soft-wooded shrub *Melianthus comosus*. Ground water is present in the river bed alluvium long after the river is dry, as borings show, and this enables tree growth to take place. The level surface of the alluvium is occupied by a fairly dense growth of trees 15-25 feet in height, the most important being *Rhus lancea* (Kareeboom), *Acacia Karoo* and *Royena pallens*. On the branches of these occur species of Loranthus and Viscum as parasites. The destruction of trees for fencing posts and firewood has led to the denudation of this stream-bed woodland, and its place is taken by a shrubby growth in which *Salsola aphylla* (Ganna) and *Lycium tetrandrum* are dominant, while species of Psilocaulon and some trailing and annual Mesembryeae also occur abundantly. This vegetation is of a distinctly halophytic character, the alluvial soil being strongly brak. An analysis of the water obtained from a shallow well in the alluvium gave the following figures (Professor Tietz):—

Residue on evaporation	185	parts per 100,000
Residue on ignition	155	,,
Alkalinity as CaCO$_3$	25	,,
Calcium as CaO	11	,,

Magnesium as MgO	16	parts per 100,000
Sulphate as SO_4	12	„
Chloride as Cl	60	„
Iron	nil	

Stream-side Vegetation.

Where temporary streams cut through the rocky ground at a steeper angle, alluvial deposits are very scanty, and river-bed woodland does not occur. The course of the stream, however, is marked by certain characteristic plants especially *Royena hirsuta.* The guarri, *Euclea undulata*, is also more abundant along streams, though scattered over dry hillsides also. Other characteristic plants are the spiny and almost leafless *Lebeckia pungens*, the vigorous climbing *Asparagus aethiopicus*, and *Galium tomentosum.*

Dry Karoo Associations.

Three floristically distinct associations can be recognised in the Whitehill area, depending on the nature of the soil.

(a) *Association of deeper soils.* This is dominated by *Mesembryanthemum spinosum*, about a foot in height without spaces between the bushes, and to the exclusion of practically all other plants.

(b) *Association of rocky areas.* The greater part of the district lies on the hard blue Dwyka conglomerate, which occurs in a slightly fissured condition at the surface, with a very scanty or no covering of soil. The plant association is naturally an open one. The shrubby plants insert their roots along the steeply sloping rock fissures and penetrate to a fair depth: of these a large number of species occur of which the most important are the Compositae *Chrysocoma tenuifolia*, *Pentzia virgata*, *Eriocephalus glaber*, *E. eximius*, *Pteronia pallens*, *P. Foleyi*, *Hirpicium echinulatum*, *Felicia muricata*, and also members of other families such as *Zygophyllum maculatum*, *Hermannia pallens* and other species, *Galenia fruticosa*, two or three species of Tetragonia and very many others which may be locally abundant.

Succulent plants are plentiful in this type of association. Some of them are of the much branched shrubby type and really belong to the shrub layer: of these the most noteworthy are *Mesembryanthemum spinosum* and several other Mesembryeae such as species of Aridaria, *Ruschia stellata*, *R. karooica*, and *R. crassa*; *Euphorbia Mundii*, *Crassula subaphylla*, *C. divaricata*, *C. Loganiana*, *Sarcocaulon Patersonii*. Other succulents are robust plants such as *Cotyledon orbiculata*, *C. reticulata*, and *C. Wallichii*, while rocky outcrops bear such striking succulents as *Euphorbia heptagona* and *Aloe parvispina*, as well as *Sarcocaulon Burmannii*, the curious *Anacampseros papyracea* and species of Conophytum wedged in the smaller crevices. A large number of other succulent plants occur, many of them usually close under the bushes, others tending to clothe the ground between. *Cheiridopsis cigarettifera* is an abundant mat-forming plant, and *Cephalophyllum curtophyllum* is a common trailer. The northward-pointing *Cylindrophyllum calamiforme* occurs in local societies. Two small Aloes, viz., *A. variegata* and *A. longistyla* and a Gasteria, *G. Zeyheri* occur sparingly, while *Haworthia margaritifera* is locally plentiful. A large number of Stapelieae occur, *Stapelia Pillansii* being the most frequent and conspicuous: other species, present in smaller quantities and usually hidden at the base of shrubs, are *Stapelia rufa*, *Piaranthus comptus*, *Huernia Pillansii*, *H. clavigera*, *Pec-*

tinaria asperiflora, and some others. Remarkable small species of Crassula occur frequently, especially C. *Archeri* and C. *columnaris* on open ground and C. *orbicularis* under bushes. In the shelter of shrubs also are found *Haworthia arachnoides*, three-quarters buried in the soil, the trailing *Kleinia radicans* and the very similar *Senecio abbreviatus*, *Anacampseros telephiastrum* and *A. filamentosa*. This list of species could be considerably lengthened, the association on Dwyka conglomerate being exceedingly rich in succulent plants.

Geophytes are also very well represented, and include several species of Albuca and Urginea, the striking " stemless " *Massonia obovata*, *Androcymbium cuspidatum*, *A. Burchellii*, *Lapeyrousia fistulosa* and *Polyxena pygmaea*, small species of Lachenalia, Ixia, Syringodea, Brunsvigia, Rhadamanthus, Eriospermum and Schizobasis, and many other petaloid Monocotyledons. Dicotyledons include several species of Oxalis, *Crassula Saxifraga*, *Pelargonium moniliforme*, the remarkable tuberous *Aridaria resurgens*, the twining *Cyphia volubilis* and the following with very large perennating tubers, *Pachypodium bispinosum*, *Fockea Comaru*, *Kedrostis punctulata*.

Of " herbaceous " plants in the ordinary sense, very few are found in this association. *Dianthus micropetalus*, *Hermannia nana*, *Aptosimum indivisum*, and a few grasses e.g. *Aristida vestita*, *Eragrostis curvula*, *Danthonia purpurea*, *Ehrharta calycina*, *Fingerhuthia africana*, are almost the only perennials: the absence of summer rains being unfavourable to this class of plants. Annuals are, however, abundant and in a good season cover the bare spaces between the shrubs, their flowers occasionally making a bright display of colour. Among them are *Zaluzianskya* *inflata* and other species, *Nemesia anisocarpa*, *Felicia adfinis*, *Amellus strigosus*, *A. microglossus*, *Leyssera tenella*, *Cenia microglossa*, *Matricaria dichotoma*, *Ursinia annua*, *Ifloga polycnemoides* and the grass *Danthonia tenella*.

Finally, on the bare rock surface occur several species of lichen and the mat-forming moss *Grimmia pulvinata*.

The above account applies to level or gently inclined ground, but on steep slopes considerable differences are noticeable: this being due partly to different degrees of insolation, and the occurrence of deeper rock-crevices and soil pockets. On *north* slopes in the Dwyka conglomerate it is frequent to find a dense covering of large spreading bushes of *Crassula perfossa*, and colonies of *Aloe microstigma* and *Euphorbia mauretanica*, together with *Pteronia Foleyi* and some other shrubs. *South* slopes on the contrary have a much reduced insolation, and the shadier and moister conditions which prevail allow of the growth of a very distinct association of plants. Here we find shade-loving Crassulas such as *C. barbata*, *C. Weissii* and *C. scalaris*, tuberous and other Pelargoniums such as *P. ovatostipulatum*, ferns such as *Pellaea andromedaefolia*, characteristic Mesembryanthemums such as *M. pygmaeum*, *Stachys rugosa*, Brunsvigias, *Cotyledon Phillipsiae*.

(c) *Association on quartzites.* In the Whitehill and Matjesfontein district several areas occur in which the soil is derived from quartzite inclusions in the conglomerate. These areas may be of considerable extent and are usually strewn thickly with rounded or angular fragments of light coloured rock, the scanty soil being of a more sandy nature than that on the conglomerate proper. These areas possess a special vegetation of their own which is sparser than on the conglomerate, but tends to grow taller. *Pteronia flexi-*

caulis is characteristic, and so are certain species of Crassula, e.g. *C. pyramidalis*, *C. pachyphylla*, and *C. Purcellii*. *Pelargonium alternans* and *P. ferulaceum* are typical thick-stemmed shrubs, and such plants as *Kleinia acaulis*, *Crassula canescens*, *Caralluma ramosa* and the large *Crassula Cotyledon* also occur.

In a few spots the ground may be strewn with smaller fragments of white quartz, and here we may find such small grey Helichrysums as *H. laneum*, *H. silicicolum* and *H. Archeri*, as well as an abundance of the white *Anacampseros papyracea*.

Other Associations.

The Ecca beds of Ngaap Kop bear a Karoo vegetation which differs in some respects from that of the Dwyka, especially on the northern aspect, where the usual *Aloe microstigma* - *Crassula perfossa* association is replaced by an open vegetation including *Asparagus striatus*, Trichocaulon sp., *Caralluma ramosa*, *Buphane disticha*, Euphorbia spp., and a number of shrubby plants.

The white gypsum band between the Ecca and Dwyka beds is almost sterile, except for half-buried mats of the remarkable *Gibbaeum perviride*, which is practically confined to this soil.

Transition to Cape Vegetation.

On the southern side of the Whitehill-Matjesfontein Karoo area, at a distance of about three miles from the railway the Witteberg quartzites crop out in a folded range of mountains rising to 5,000 ft. altitude. These mountains provide a distinct habitat for plants for several reasons. Their greater altitude brings about a somewhat higher rainfall, and their crest is frequently shrouded in the south-easterly cloud during the summer. The soils derived from the sandstone rock are poorer in soluble plant food than the relatively rich soils from the Dwyka conglomerate, and their consistency is lighter and more porous. Moreover, the rock fissures are deeper and larger shrubs can exist than is generally the case on the Karoo. These various factors, combined no doubt with others more subtle, result in the development of a Cape vegetation on the Witteberg range. The effect of the climatic factors is clearly shown by the fact that on the southern slopes of the mountains this Cape vegetation occurs down to as low as 3,300 ft., while on the northern side it is very scantily developed below about 4,500 ft.

This Cape vegetation is rich in species, totally distinct from that of the adjoining karoo: in fact, no single species is common to the two formations. Details cannot be given here; suffice it to say that on the Witteberg occur at least 16 species of Proteaceae, 22 species of Ericaceae, 15 species of Restionaceae, 7 species of Rutaceae, and a large number of other typical Cape plants. The contrast between Cape and Karoo vegetation is most striking, both floristically and ecologically.

At the foot of the Witteberg there occurs a transitional zone between the Cape and Karoo areas, this having certain features of its own, and differing from the formations on either side. The quartzite rocks bear a flora dominated by twiggy freely-branching shrubs, for the most part inedible to stock and therefore less distorted in shape than the Karoo shrubs. Examples are *Phylica lasiocarpa*, *Passerina glomerata* and several species of Pteronia, Relhania, Elytroppapus and other Compositae. Succulent plants are scarce in this association, which thus differs from typical Karoo. On the other hand there are no Proteaceae, Ericaceae and Restionaceae.

It is remarkable how distinct this transitional association is from the association on included Karoo quartzites on the one hand, and from the Cape association on the other. As one ascends the slopes of the mountain from the transitional zone one suddenly reaches outlying shrubs of *Protea marginata* and simultaneously one notes the occurrence of two or three species of Restionaceae and one or two Ericaceae (minor genera). The change is all the more striking because there is no obvious correlated change in the character of the environment.

This transitional zone with its numerous Compositae and poverty in succulents is found over a very wide extent of country in the Western Cape; and one almost invariably traverses it, as a broad or narrow zone according to circumstances, in passing between a Cape and a Karoo type of vegetation.

THE LITTLE KAROO.

The western portion of the Little Karoo, sometimes known as the Ladismith Karoo, lies mainly on Bokkeveld shales and quartzites. The altitude is somewhat less than the Western Karoo, Ladismith being 1,860 feet and the southern margin of the Little Karoo about 1,000 ft. The average annual rainfall is 10-15 inches, most of which falls in winter. The soil is on the whole more sterile than that of the Western Karoo, and the vegetation scantier.

A well-marked transitional zone lies along the southern margin of the Little Karoo, passing into the Cape vegetation on the sandstone of the Langebergen on the southern side and into the true Karoo vegetation on the northern. The Montagu-Barrydale road passes mainly through this belt, which, as elsewhere, is characterised by abundant shrubby Compositae and few succulents.

The flora of the Little Karoo is strikingly different from that of the Western Karoo. This is particularly true of the succulents. The whole district is exceedingly rich in Mesembryeae, including some of the most highly modified types. The genus Gibbaeum is especially well represented, and other striking plants are *Muiria Hortenseae, Argeta petrensis, Rimaria Heathii* and species of Glottiphyllum and Conophytum. A striking feature of the area is the occurrence of tracts covered uniformly with white quartz fragments: the subsoil being a close clay. It is on this type of ground that the most remarkable succulents grow. These "white patches" frequently bear very light-coloured, grey or white plants (glaucous or pubescent). Horizontal ones may be covered with a uniform growth of *Gibbaeum pubescens.* Gentle slopes have the half-buried and almost invisible G. *molle* and G. *pilosulum*, or in some cases, the white G. *album*, and the grey *Muiria Hortenseae* and *Argeta petrensis.* Shrubs are scarce or absent on these white patches, perhaps owing to imperfect subsoil aeration. The succulents above-mentioned are entirely confined to the white patches: but the converse is not true, for many white patches exist without them.

On the north side of the Little Karoo the steep and picturesque hills have a vegetation which includes certain outliers from the country further east. The most striking of these is the tree succulent *Portulacaria afra*, and others are *Aitonia capensis, Carissa Arduina, Aloe speciosa,* Testudinaria sp., and certain Acanthaceae. Northern and southern aspects on these kopjes show striking differences in vegetation, the rainfall being about the critical limit of 14 inches.

THE DOORN AND TANQUA KAROO.

Great stretches of this are covered with plant associations dominated by *Mesembryanthemum spinosum* and *Pteronia pallens*, these occupying the prevailing sandy ground derived from the sterile Witteberg sandstone. Large areas of fine brak river-silt occur, dominated by an open growth of *Salsola aphylla*, with which are associated other Chenopodiaceae, viz. *Atriplex Halimus*, *A. albicans*, and Suaeda sp., with Lycium sp., *Melianthus comosus* and some others. On stony ground occur such curious succulents as *Didymaotus lapidiformis* and *Punctillaria Roodiae*, with other Mesembryeae.

THE ROGGEVELD AND CALVINIA KAROO.

In the Nieuwoudtville district, with a winter rainfall of about 12 inches and a fairly uniform altitude of about 2,500 ft., the different rock formations determine the types of vegetation with considerable precision. On the "red ground," derived from diorite outcrops, an Eriocephalus sp. is dominant and there are large numbers of bulbous, herbaceous and annual plants, e.g. species of Bulbine, Sparaxis, Ixia, Massonia, Gethyllis, Arctotis, Nemesia, Diascia, Ursinia, Berkheya, Venidium, etc. The sandy soils derived from the Table Mountain Sandstone, forming the Bokkeveld Mountain escarpment, have a true Cape flora, with at least four species of Protea, three of Leucadendron, three Ericaceae, and species of Nivenia, Leucospermum, Restio, Cannamois, Thamnochortus, Phylica, Diosma, etc., with a few bulbous plants and many annuals: while on the rocky outcrops are Aloes, Cotyledons, Crassulas, etc. The third type of soil is derived from the Karoo rocks of Dwyka age, and this bears a typical Karoo plant formation dominated by Mesembryeae, of which *M. spinosum* is the most abundant. Almost the whole flora is succulent, consisting of Mesembryeae of shrubby and trailing types, with *Aloe Krapohliana*, Carallumas, Euphorbias, *Cotyledon Wallichii*, *Euphorbia mauretanica* and *Galenia africana*: annuals, bulbous and herbaceous plants are relatively scarce.

This district provides a clear demonstration of the way in which, at the critical limit of rainfall, soil factors may determine whether a Karoo vegetation or some other plant formation shall occur. The precise nature of these soil factors, however, still awaits investigation.

THE VAN RHYNSDORP KAROO.

The lesser altitude (about 1,000 ft.), lower rainfall (about 5 inches), and high temperatures in this district produce a Karoo formation of a very arid type on the Ibiqua beds. Mesembryeae are dominant in a very open formation, including shrubby Psilocaulons, deciduous Schwantesias, Conophytums, *Argyroderma testiculare*, *Roodia digitifolia*, etc., and also *Aloe falcata*, *Euphorbia fasciculata* and other striking succulents. This association passes gradually into that of the Hardeveld and Barren Karoo in which vegetation is even more restricted.

THE ROBERTSON KAROO.

The rainfall is about 12 inches, and on the Bokkeveld, Ecca and Dwyka beds a Karoo formation is developed, with such conspicuous plants as *Cotyledon paniculata*, *C. Wallichii*, *Euphorbia mauretanica* and *Urginea altissima* abundant, associated with many Mesembryeae and Stapelieae, Gasterias and Apicras, and such striking bulbous plants as Massonias and *Bulbine mesembryanthemoides*, etc.

SOME CHARACTERISTICS OF KAROO VEGETATION.

Root Systems.

The shrubby species are typically deep-rooting: the succulent species (with rare exceptions, e.g. Euphorbia spp.) have a spreading root system just below the surface. Thus the succulents are able to take advantage of occasional dews and light rains, which do not affect the shrubs. A comparatively light shower, after a long period of drought, will swell the succulents to turgidity but will not affect the woody plants: these latter requiring a more abundant rain to start growth. On the other hand, the shrubs have extraordinary powers of drought resistance, despite the general absence of such "xerophilous adaptations" as hairiness, resting buds, etc.; and this is probably due in part to their deep root systems.

Position of Succulents.

The small succulents are very commonly found growing at the base of shrubs. This is probably due to various causes, of which the chief is the slightly greater moisture of such situations. This enables germination to take place and the seedlings to become established: and then, since the surface-rooting succulent scarcely competes with the deep-rooting shrub, the two are able to grow in close association. Another factor is that, under the shelter of hard woody or thorny bushes the succulents are more immune from the trampling and browsing of herbivorous animals.

In many cases small succulents are found in the partial shelter of rocks and stones, these acting in much the same way as shrubs: moreover the effect of a stone lying on the soil is to mitigate the intense heating effect of the sun upon the soil which appears in some cases to have an adverse effect on the shallow root system of the succulent.

Many succulents, however, habitually live in complete exposure, e.g. *Crassula columnaris*, *C. pyramidalis* and other species. Others not only live in full sun, but normally inhabit bare rock outcrops, in the crevices of which they insert their roots: such are many species of Conophytum, *Anacampseros papyracea*, *Sarcocaulon Burmannii*, etc.

Other Features of Succulents.

With the exception of the Aloineae (Aloe, Gasteria, Apicra and Haworthia) and some Euphorbias the Karoo succulents are deficient in mechanical tissue and have relatively thin cuticles: very few of them have a dense hairy covering (e.g. *Kleinia Haworthii*), and the slight pubescence of some can hardly be a xerophilous feature (e.g. *Gibbaeum pilosulum*, *Muiria Hortenseae*). There is seldom any well-defined aqueous tissue, but the whole plant is filled with a pulpy parenchyma which is rich in mucilage and which retains moisture strongly.

Bulbous plants.

These are very numerous and range from the enormous bulbs of Buphane and Brunsvigia to the small corms of Ixia, Syringodea, etc. Many of the bulbs have a very soft mucilaginous texture, and apparently serve as reservoirs of water as well as of food materials. The leaves are frequently slender and spirally twisted, e.g. in several species of Albuca, Gethyllis, Bulbine, etc. In a few instances the leaves may be succulent as in *Bulbine mesembryanthemoides* and *B. succulenta*, in others there may be a clothing of hairs, e.g. Gethyllis spp., but usually they are of no specially xerophilous appearance. The bulb tunics are often very numerous and persistent, fibrous or indurated. In specially dry seasons the bulbs may entirely fail to grow, and in the majority of cases even a heavy summer rain has no effect upon them: but a good rain in May or June stimulates them to prompt growth. The majority of them are spring-flowering; but a few (especially the Amaryllidaceae) flower in the late summer in the leafless condition, and the seeds which often have no resting period are ready by the time the winter rains begin.

Plants with Perennial Tubers.

Some of these have perennial shoots above ground (e.g. *Pachypodium bispinosum*) but the majority have annual shoots which appear at the beginning of winter (e.g. *Fockea Comaru*, *Kedrostis punctulata*, Cyphia spp.). Such plants are frequently twiners and the climbing species of Asparagus and Testudinaria are other examples of a similar tendency. The Eriospermum spp. which have potato-like tubers flower and leaf at different seasons. Certain Cotyledons have subterranean tubers in addition to succulent deciduous leaves.

Rhizomatous and stoloniferous plants are very rare in the Karoo formation. *Aloe variegata* and *Euphorbia stolonifera*, however, propagate by underground runners.

The Gramineae are all of the tufted type, and there are no Cyperaceae, Juncaceae or Restionaceae in dry ground.

Annual Plants.

These appear in myriads after a good rain in May or June. Rains during the summer, however, cause practically no germination, just as in the case of the bulbs. In drought years annuals are very scarce, the seeds being able to lie dormant for several years awaiting a sufficient rain. If the rain be sufficient to start germination the seedlings appear in a very few days and quickly produce two or three leaves and a flower or two: if further rains occur growth proceeds, but if not the plantlet sets a few seeds and dies, its whole life only extending over a few weeks.

The annuals are plants with little or no xerophilous character: they grow only in the winter when atmospheric humidity is relatively high and evaporation and insolation are at a minimum. They are opportunist ephemerals of an extreme type: and it is a very rare occurrence for annuals to be able to flourish to such an extent as to carpet the Karoo with flowers.

Karoo Shrubs.

These are mostly of low stature, but this is accentuated by the severe grazing to which they are subjected. The majority of them have small slender leaves borne in considerable numbers: one of the rare exceptions is the broad-leaved guarri, *Euclea undulata.* Latex is infrequent, but resinous, waxy and aromatic secretions are almost universal, species of Euryops, Pteronia, Chrysocoma, Tripteris, etc., being conspicuous in this respect: and doubtless this is one of the chief factors in their xerophily. Most of them "break" freely (in the gardening phrase) after being eaten back. Very few are deciduous. Spinescence is not frequent, exceptions being shrubby species of Asparagus and Lycium. Apart from an occasional Helichrysum very few of the shrubs are markedly hairy.

Protection against Grazing.

The game animals of yesterday and the goats and donkeys of to-day are a powerful ecological factor, and resistance to grazing is a condition of survival. This is accomplished in various ways.

(a) *Unpalatability and Toxicity.* Many plants are only grazed under conditions of extreme scarcity, and some not at all. Examples of unpalatability are *Galenia africana* and *Chrysocoma tenuifolia* which tend to increase in overstocked areas: also many species of Aloe, Pteronia, and Mesembryanthemum. Definite toxicity is well-known in *Cotyledon Wallichii* and *Pteronia pallens* and these are avoided by Karoo animals, though they may be eaten (with ill results) by stock freshly brought to the district. Latex, resins, aromatic and bitter substances are doubtless checks to grazing: but animals constantly nibble young shoots of certain copiously laticiferous plants such as *Euphorbia mauretanica*, and the aromatic Pentzia spp. are one of the chief stock foods.

(b) *Powers of Regeneration.* The edible plants are eaten back to the old wood by goats and donkeys, but survive through their powers of regeneration. Examples of this are Pentzia spp., Tetragonia spp., *Phaeoptilum spinosum*, Hermannia spp., etc. Under modern conditions of overstocking, however, these plants get little opportunity of regenerating by seed and are gradually being supplanted by species valueless to stock.

(c) *Spinescence.* This appears to be rather a physiological reaction than a protective adaptation. It may, however, act as a deterrent to grazing as in Asparagus, Lycium, Apicra and Euphorbia spp.

(d) *Inconspicuousness.* Many of the Mesembryeae closely resemble the stones among which they grow, e.g. *Pleiospilos Bolusii, Didymaotus lapidiformis.* Others are normally buried in the soil and only expose their leaf-tips e.g. Lithops spp., *Gibbaeum molle*, and during the dry season these may disappear entirely below ground. It is probable, however, that inconspicuousness is over-rated as a protective adaptation: the keen eyes of hungry animals could hardly miss many of these "mimicry" plants, and moreover when they are in flower they are often extremely conspicuous even to human eyes. The occurrence of white plants on white quartz-strewn ground is often quoted as a mode of concealment: but the most typical of these, *Gibbaeum pubescens*, makes a conspicuous display of magenta flowers. Such a typically white plant as *Anacampseros papyracea* is found as often on dark-coloured rocks as it is on the "white patches'": though in this instance the adaptationists claim that it mimics the excreta of birds, which are naturally not confined to white ground!

The Floristic Features of the Karoo.

R. H. COMPTON.

THE KAROO is bounded on the north and east by a " Northern " flora continuously linked with that of Central Africa; and on the South-West by a " Southern " or " Cape " flora whose affinities are with the floras of other circumantarctic land masses. The Karoo flora is at first sight a miscellaneous assemblage of floristic elements derived from its " northern " and " southern " neighbours, but certain factors or principles can be recognised according to whose application the Karoo Flora has been selected. The chief of these are aridity and grazing. Both tend to act in the same way, namely by destroying the parts of plants above ground: and in response to these factors the most striking features of the Karoo flora are storage, unpalatability and regeneration.

The Karoo flora includes no representatives of some of the largest and most characteristic southern or Cape families. There are, for instance, no Karoo Proteaceae, Ericaceae, Restionaceae, Bruniaceae, Penaeaceae, Rhamnaceae and Rutaceae, although these groups come into close contact along narrow boundaries with Karoo associations: the reasons for their absence afford an interesting and unsolved problem. It may be pointed out, however, that many of them are " hard-wooded " shrubs which do not " break " readily after the killing back of their shoots by drought or grazing: and moreover that succulence, geophily and the production of resins, essential oils (except in Rutaceae), etc., are features not found in these families. On the other hand, some families mainly southern in S. Africa are able to penetrate the Karoo: for instance, the Iridaceae have several Karoo representatives, apparently on account of their geophily, and the Crassulaceae and Geraniaceae on account of succulence and geophily. The succulent Mesembryeae have also probably southern antecedents.

The woody flora of the Karoo is largely representative of families with a general northern and southern distribution, for instance the Compositae, Leguminosae, Sterculiaceae, Solanaceae, Rubiaceae, Ebenaceae and Anacardiaceae. A large percentage of these plants are both distasteful to stock and highly drought resistant, apparently for chemical reasons (resins, mucilages, bitter and aromatic substances), while those which are palatable to stock are possessed of great powers of regeneration.

The opportunist annuals belong to genera widely distributed in all parts of South Africa, e.g. Felicia, Ursinia, Diascia, Zaluzianskya, Heliophila, Sebaea, etc. Other herbaceous elements, e.g. Gramineae, are scarce and may be outliers of northern (e.g. Fingerhuthia, Aristida) or southern (e.g. Ehrharta, Danthonia) genera.

Geophily, exemplifying storage and survival of grazing, is most conspicuous in the bulbous Monocotyledons, and the families Liliaceae and Amaryllidaceae are strongly represented in the Karoo. Many Dicotyledonous genera have also taken advantage of geophilous potentialities to colonise Karoo areas, noteworthy examples being Oxalis, Cyphia, Pachypodium, Pelargonium and some Asclepiads and Cucurbits.

Succulents, combining storage with distastefulness, are the most distinctive constituents of the Karoo vegetation, though succulents occur to some extent in both northern and southern plant formations outside the Karoo. Of the families yielding succulents, the typically stem-succulent Euphorbiaceae and Asclepiadaceae are mainly of northern affinities, while the leaf-succulent Aizoaceae and Crassulaceae have strong southern affinities.

Finally, the Karoo stream beds contain arboreal extensions of the northern and eastern tree-veld, and Acacia and Loranthaceae invade along these lines.

The Archegoniatae of the South West Cape

R. H. COMPTON.

The systematic knowledge of the Archegoniatae of South Africa is largely due to the work of Dr. T. R. Sim, whose two monographs* not only summarise the earlier scattered work, but also incorporate a large amount or original observation and research; and much use has been made of them in what follows.

I. PTERIDOPHYTA.

The Pteridophytic flora of this warm temperate region occupies an intermediate position, as judged by wealth of genera and species, between the vast riches of the tropics and the comparative poverty of the colder temperate regions. A comparison with, say, Great Britain is interesting. In that country there occur 17 genera and 38 species of Ferns, whereas in the Cape Peninsula alone we find 25 genera and 53 species, or about half as many again. The Cape Pteridophyta contain representatives of practically all the larger groups, and moreover a very wide range of habitat and plant form is evinced within the group.

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*T. R. Sim "The Ferns of South Africa", ed. II. 1915.
T. R. Sim. "The Bryophyta of South Africa". Trans. Roy. Soc. S.A., XV., pp. 1-475. 1926.

Lycopodiales.

The Lycopodiales are represented, though sparingly, by members of all three living families, but these are only found in relatively moist situations, consequently great tracts of country are quite devoid of them. Among the Lycopodiaceae, *Lycopodium carolinianum* is frequent on moist peaty soil in sandstone mountain districts, *L. cernuum* occurs on moist earthy banks in Bain's Kloof and Mitchell's Pass, and *L. clavatum* is found, though rarely, on mountains above 4,000 feet in the coastal belt. These species have a wide geographical range, whereas the other species, *L. gnidioides*, which has an almost epiphytic habitat on rock-ledges at altitudes above 1,500 feet is confined to southern Africa and the Mascarenes. The Selaginellaceae are represented by one species only, the small erect homoiophyllous *S. pumila*, which is locally abundant, e.g. in the Stellenbosch Flats. The Isoetaceae are represented by three species in the Cape and Stellenbosch Flats: two of them, viz. *I. capensis* and *I. Stephansenii* live in temporary vleis, the latter having a two-lobed stem, while *I. stellenbossiensis*, which is distinguished by the non-development of the velum, occurs in marshy spots but often spreads on to dry ground, and is described as forming a close turf in some cases.

The Karoo areas are apparently without a Lycopodialean flora.

Little is known as to the life-histories of the species of Lycopodium under S. African conditions. The work of Miss Duthie has, however, thrown considerable light on Selaginella* and Isoetes.†

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*A. V. Duthie. Trans. Roy. Soc. S.A., X. p. 201. 1922; and XI. p. 131. 1924.

†A. V. Duthie. Ibid. XVII. p. 321. 1929.

Filicales.

The Filicales play a relatively small part in the vegetation of the South-west Cape as a whole; but they occur in most of the plant associations, and occasionally achieve a partial dominance.

The coastal belt will first be considered. In the broad-leaved evergreen forest of shady kloofs Ferns are abundant and often form the greater part of the herbaceous undergrowth. On dripping rocks in such situations we find filmy ferns such as *Hymenophyllum Marlothii* with its coating of rusty hairs, and the glabrous *H. fumarioides*, both with soft pendulous fronds an inch or two in length; and the handsome *Blechnum attenuatum*, with its vivid red young leaves, is often associated with them. Moist slopes in the forest are frequently occupied by the graceful tree-fern *Hemitelia capensis*, rarely exceeding a height of six feet owing to its slender trunk; and large plants of *Pteris dentata*, *Blechnum capense* and *Todea barbara* are frequent associates. The last two species are also frequently found outside the forest in a more stunted form where moisture is adequate; for instance above 2,000 feet in the south-easterly cloud-belt, and in open swamps. Other frequent ferns in dense shade and abundant moisture are *Asplenium monanthes*, *A. lunulatum*, *A. erectum* and *A. praemorsum*. Drier parts of the forest, away from streams, have *Adiantum capillus-veneris* and *A. aethiopicum*, *Asplenium adiantum-nigrum*, *Polystichum aculeatum*, *Blechnum attenuatum* and *B. australe*, *Pellaea viridis* and *P. pteroides*, some of these species also tolerating a higher light-intensity and entering the marginal tree-shrub association. Finally, as rock and tree epiphytes in moist air and forest shade occur *Hymenophyllum tunbridgense* and *Polypodium lanceolatum*, both of which wilt completely in spells of dry weather, reviving at the onset of rain.

In the scrub association ferns play a small part, though in many localities at low altitudes on a light acid soil with a good rainfall *Pteridium aquilinum* may temporarily dominate clearings and burnt areas. Characteristic ferns of the scrub on open hillsides are the Schizaeaceous *Mohria caffrorum* with deciduous habit and *Schizaea pectinata* with linear evergreen leaves, which occur when the rainfall is adequate. When, however, the rainfall is less than about 25 inches, ferns of a more xerophilous type occur, chiefly in rock-crevices; such are *Pellaea hastata* with glaucous coriaceous pinnules, *Cheilanthes hirta* with a copious glandular tomentum, *C. multifida* whose small pinnules have reflexed margins, *Adiantopsis capensis*, and most striking of all *Ceterach cordatum*, the lower surface of whose frond is covered with a dense coating of brown ramenta; all of these ferns undergo a long resting period during the dry summer months.

The temporary vleis and marshes of sandy flats are deficient in ferns, but the permanent swampy patches and "flushes" of mountain-sides may have a copious growth of *Blechnum capense* with or without *Todea barbara;* and the cosmopolitan social swamp fern, *Dryopteris Thelypteris*, occurs locally in these situations in dense masses with Cyperaceae and Juncaceae.

There remain a number of species whose usual habitats are at altitudes above 1,500 feet, where moisture is provided in summer by the south-easterly cloud, though they may occur also in specially moist situations at lower levels. *Gleichenia polypodioides* is a typical example, occurring in shaded rock-crevices at higher altitudes, but occasionally found in bushy masses near streams at lower levels; while in the Knysna forests with an all-the-year-round rainfall it is very abundant at low altitudes. Other montane ferns are *Polystichum adiantiforme*, the shortly arborescent *Blechnum tabulare*, the slender *Schizaea tenella* on rock-ledges at high levels, by streamsides at low, and *Elaphoglossum conforme* with simple leathery leaves on vertical shady rock surfaces.

Many of the ferns of the coastal districts show interesting biological features. The xerophytic ferns, such as may be seen on the western slopes of the Cape Peninsula, have already been mentioned. *Hemitelia capensis* is well-known to pteridologists on account of the curious aphlebiae or basal pinnae which closely resemble the fronds of a Trichomanes and which form a green interlacing mass over the growing apex of the stem; if the young frond is amputated just above its base at an early stage of development, the rudiments which would normally become aphlebiae grow out into pinnae of the normal or an intermediate form. The curious infra-axillary aborted branches are well seen on the Hemitelia trunk; and the branching tendency is also well illustrated by the way in which, after injury to the main trunk, new ones may arise from the base. *Anogramma leptophylla*, only known in two localities in the Cape Peninsula, is remarkable in having a perennating gametophyte and an annual sporophyte, the latter being only an inch or two in height. *Polypodium lanceolatum*, the only true epiphyte among the vascular plants of the whole region, has adopted the introduced *Quercus robur* as a favourite host in various moist localities, e.g. in Newlands Avenue. *Osmunda regalis*, which is said to have been eradicated in the Cape Peninsula, has been recorded in several localities in our area; its geographical distribution offers an interesting problem, as does that of the circumantarctic *Todea barbara*, the other native Osmundaceous fern. The Aspleniums, especially *A. monanthes* and *A. lunulatum*, frequently propagate by means of proliferous frond-apices.

Among the Ophioglossaceae only one genus, Ophioglossum, is represented, and three species have been recorded in the South-West Cape, of which the most interesting is the minute O. *Bergianum*, 1-2 inches high, in which the sterile and fertile fronds often arise separately from the rhizome.

Marattiaceae are not present in our area, but one species, *Marattia fraxinea*, is one of the chief ornaments of the Knysna forests.

Of the heterosporous groups, only *Marsilia macrocarpa* occurs, and that infrequently, in moist muddy places, extending to the Karoo.

Turning now to the Karoo areas, we find a quite unexpected number of ferns present. All of them are of a markedly xerophilous type, some growing in the bare sun-baked ground, others occupying the slight shelter of rock-crevices. Practically all the species belong to the Cheilanthineae, a group productive of xerophilous forms in other parts of the world also. Some of the species are dark in colour, with numerous leaflets with reflexed margins, and scaly or glandular pubescence; their aerial portions form dense erect tufts which dry off completely for the greater part of the year. Such are *Cheilanthes depauperata*, C. *hirta*, C. *contracta* and C. *induta*. In rock-crevices with a northern aspect occurs *Doryopteris deltoidea*, and in those with a southern aspect the somewhat similar *Pellaea lancifolia*, both forming bright green tender leaves after a good winter rain. *Ceterach cordatum* is a strikingly xerophilous type and is frequent in sheltered rock-fissures. Of special geographical interest is *Pellaea andromedaefolia*, abundant on southern slopes in some Western Karoo localities, and indistinguishable from a Californian species.

Little is known of the life-history of these remarkable ferns. It is clear that the sexual life-cycle can rarely be completed. On the other hand they appear to have relatively little power of vegetative propagation apart from a slow spreading by rhizome growth. The physiological features enabling drought resistance in the Karoo ferns are also unknown. Though relatively shallow-rooted they show no trace of succulence, and in the summer the whole plant becomes dry and brittle. It is probable that the method of tiding over the long periods of drought is analogous to that of the " resurrection plants " — whatever that may be.

II. BRYOPHYTA,

The Bryophyta of the South-West Cape have been the subject of a fair amount of systematic work, but they have not so far received the attention they deserve from the biological and ecological points of view. It is clear from general observation that in this area, as in other parts of the world, the Bryophyta may be used with great precision as indicators of habitats; the relative simplicity of their relation to substratum and atmosphere, as well as the small space they occupy, renders them specially valuable in this respect. In spite of this, however, the ecology of the Mosses and Liverworts has received practically no attention, though this is perhaps not surprising in a country of few botanists where the outlines of the ecology of vascular plants are as yet scarcely traced.

Suitable habitats for the growth of Bryophyta are even more limited in the South-West Cape than for the Pteridophyta. They occur, however, in considerable profusion in the moister parts of the coastal belt, especially on rocks and trunks in the forest formation at high altitudes where moisture in summer is supplied by the south-easterly clouds. They are comparatively scarce, however, in the more open associations of loose soil on hillsides or sandy flats. In the arid mountains bordering the Karoo only a handful of species occur, and on the Karoo itself the number is extremely limited.

Hepaticae.

Dealing first with the Hepaticae, we find the Sphaerocarpaceae represented by one of the most remarkable genera, Riella, with a single aquatic species, *R. capensis*, in vleis on the Cape Flats. This plant, with its thickened "midrib" and its one-sided undulating membrane offers particularly favourable opportunities for the study of development of reproductive organs, the dioecious plants bearing antheridia and archegonia in a close acropetal succession. Curious gemmae are also produced.

The Marchantiaceae include several remarkable forms. The largest is *Marchantia tabularis*, a magnificent species locally abundant on moist stones and earth in the forest areas. *Lunularia cruciata* is very frequent as a weed, and occasionally fruits. *Fimbriaria marginata* is a very attractive inhabitant of firm earthy banks, and is often associated with the interesting *Targionia hypophylla*. Species of Riccia are numerous on bare soil, some even occurring in Karoo habitats (e.g. *R. albomarginata*), and showing markedly xerophilous features in thallus and dorsal hairs; they vegetate only in the winter and spring months, however, passing the summer in the form of spores.

Of the Jungermanniaceae Anacrogynae, *Aneura fastigiata* is one of the most abundant components of streamside bryophytic sods in the district, and is often associated, by mountain streams, with species of Symphyogyna showing partial differentiation into trailing rhizome and erect dichotomous fronds. Several species of Fossombronia, showing a different type of stem-leaf differentiation, also occur, frequently in society with Targionia and Fimbriaria on moist earthy banks.

The Jungermanniaceae Acrogynae are numerous and belong to well-known and widely distributed genera such as Frullania, Calypogeia, Lepidozia and Lophocolea, together with some rarities. The Frullanias are numerous, especially on relatively dry tree-trunks, and vary greatly in size from the minute *F. capensis* to the robust red *F. squarrosa.* A large number of small species occur interwoven with mosses on wet stones by streams and waterfalls, especially in forest areas; and though of interest to systematic students of the Hepaticae, little can yet be said of them from the ecological point of view. *Plagiochila sarmentosa* is one of the few large and handsome species. Various species of Lepidozia are noteworthy for their alga-like filamentous leaves. *Calypogeia trichomanis* bears curious gemmiferous shoot-tips.

Three or four Anthocerotaceae occur in the area, of which *Anthoceros natalensis* and *A. Ecklonii* appear to be the most abundant, and frequently grow in company on sodden earth near springs and by the side of permanent water. The latter has a slender sporogonium which occasionally reaches four inches in length.

Musci.

Among the Mosses we find a vast number of species, of which the majority belong, as usual, to the Bryaceae; and while these are probably of the greatest value as defining habitats, greater general interest perhaps attaches to the other families.

The Sphagnaceae are not numerous and do not form extensive bogs as in colder climates. Small masses of various species are, however, frequent at stream-margins and on dripping rocks in mountain districts, or floating in pools. The capsules have seldom, if ever, been observed in Cape material.

Of the Andreaeaceae, *Andreaea subulata* occurs on exposed elevated rocks,, as is typical for the genus, but appears to be rare.

The Polytrichaceae are represented by a few species, of which the wide-spread *Polytrichum commune* is the most abundant. *P. piliferum* is of interest as a highly xerophilous form, occurring on exposed mountains bordering the Karoo, such as the Witteberg.

Among the host of Bryaceae mention may be made of *Campylopus nanus*, a strongly xerophytic montane form, and *Grimmia pulvinata* which forms dense mats over stones in parts of the Western Karoo and spends the greater part of the year in the resting condition. Species of Fissidens are very numerous and occur generally in streamside sods and on moist rocks in the kloofs. The handsome tree-like *Hypopterygium laricinum* is noteworthy in similar situations. Species of the curious genera Pleuridium and Archidium, in which the capsule is reduced to almost a hepatic simplicity, occur in open situations in the Cape Peninsula and elsewhere. *Wardia hygrometrica* is a very frequent aquatic moss in streams at high altitudes, and is one of our most noteworthy endemics. Species of Fontinalis, however, are apparently rare.

Fresh Water Aquatic Vegetation of the South-Western Districts

EDITH L. STEPHENS.

Before describing the aquatic flora of a region in South Africa, it is necessary to make clear the local usage of "vlei" and "pan" — terms applied to standing bodies of water, but varying in their exact meaning in different parts of the country. In the south-western districts, "vlei" is used to cover any expanse of water, open or marshy, larger than a pool. ("Marsh" is used throughout this paper in its strict sense of a shallow expanse of water largely occupied by upright aquatics such as bulrush, rushes, and sedges). This differs from the usage in Transvaal and Rhodesia, where "vlei" is confined to marshy areas and seasonally flooded grass-land or damp grass-covered hollows, "pan" being used for shallow open areas liable to dry up, and "kuil" for very small pieces of permanent water, "lake" or "meer" for larger. The term "pan" is also sometimes used in the south-western districts for very shallow open depressions in which a little temporary water may collect during the rainy season, but these go more often under the general title of "vlei."

The fresh waters of the south-western districts fall naturally into four divisions: (a) seasonal vleis and pools; (b) permanent vleis; (c) streams; and (d) reservoirs. This order is that of their importance from the point of view of aquatic life, which is far more rich and varied in the temporary standing waters than in the permanent ones. Whether this statement is generally applicable in South Africa it is impossible to say as yet, but the writer's experience of aquatic collecting in the Eastern Province, Rhodesia, and the Transvaal has given the same impression. The following account deals mainly with the Cape Division, our knowledge of the aquatic floras of the other divisions of the south-west being still too incomplete to use except for incidental comparison.

The Cape Division (663 sq. miles in area), consists of three portions, the mountainous Cape Peninsula, the flat sandy isthmus of the Cape Flats (as far as Eerste River), and a strip of mainland about 15 miles broad, of flat country from which rise rolling hills, stretching up the west coast to beyond Philadelphia. To anyone visiting this region towards the end of the summer months — say in February or March — it would appear to be very poor in aquatic plant life. There is then no running water except trickles in the mountain gorges and the small Liesbeek River, no standing water except pools in the beds of some of the streams, mountain reservoirs, farm dams, and several small lakes on the Flats; and apparently little of interest in any of these. But with the coming of the rains in April and May, the scene rapidly changes. The mountain trickles become waterfalls and torrents, dry stream beds flow again, and numerous depressions on the Cape Flats become filled with water. On the mountains the change is marked chiefly by the renewed growth of Sphagnum and other bryophytes, and the re-appearance of algae on oozy banks and dripping moss-covered rock-ledges; but on the Flats the change is a much more dramatic one, and within a few weeks the newly-formed waters are teeming with a varied plant and animal life. As already pointed out, these rainy-season vleis and pools are more interesting than the permanent waters, and must take first place in our consideration of the aquatic flora.

(a) SEASONAL VLEIS AND POOLS.

These may be conveniently sub-divided for description into open (i.e. not marshy) vleis and pools; lagoons; and marshes.

(1) *Open Vleis and Pools.*

The life of these and the contrast they present between dry and wet seasons may perhaps be most usefully described by giving a general idea of what can be seen of it from the roadside in a drive on the Cape Flats, down Lansdowne road from Claremont station, or Wetton road from Wynberg station, and back by the Klipfontein road to Mowbray. Beside the road there are seen in March numerous shallow depressions, all quite dry. They vary in size and character from mere ditches or pond-hollows to stretches of field sparsely covered with short coarse grass, or areas of hardened mud sprinkled with Salicornia and red-leaved Crassula.

In September, these depressions are filled with water, on which float leaves and flowers of *Aponogeton distachyon* and *A. angustifolium*, *Limosella aquatica*, *Oxalis natans*, and *Crassula natans*. Looking down through the clear water, various submerged aquatics can be seen. *Ranunculus rigidus*, *Potamogeton exiguus*,* and *Scirpus fluitans* are common flowering-plant examples; *Riccia fluitans* is occasionally found; and where the dried mud flat stood in March, Charophyta and the water-liverwort *Riella capensis* mingle with now-submerged Salicornia and Crassula to form a many-coloured carpet, strewn with the green "marbles" of *Hydrodictyon africanum.* On either side of the causeway near St. Joseph's Shrine this carpet is studded with the green stars of *Isoetes capensis.* Algae of many kinds are present, perhaps the most striking mixture of these being seen in the flooded field near the German Church at Philippi, where large nets of *Hydrodictyon indicum* mingle with the compacter ones of *H. africanum*, and where rust-red patches mark *Sphaeroplea africana* and *S. Wilmanae* in fruit, while Volvox and filamentous algae float in the pools.

**P. pusillus*, L., in Fl. Cap., now identified by Hagstrom in his "Critical Researches on the Potamogetons" as *P. exiguus*, Hagstr. *P. pusillus*, L. apparently does not occur in S. Africa.

This will give an idea of the commoner forms of aquatic plant life that appear in seasonally flooded areas on the Cape Flats. It is not intended to list all the aquatics and semi-aquatics found, but several additional characteristic plants may be mentioned here. Three of these are bulbous, viz. *Hypoxis aquatica* and *Gladiolus biflorus*, which grow in shallow water, or even as sub-aerials in wet places, and the less common *Dipidax triquetra*, which lifts its lovely pink spikes out of deeper areas. Three species of Cotula also deserve mention. C. *myriophylloides* is a remarkable submerged Composite with the aspect of a Myriophyllum, and C. *coronopifolia* and C. *filiformis* are characteristic vlei-haunters. (Quite a long list could be given of these vlei-haunters, i.e. plants which, though not real aquatics, grow best when standing in water and may become dwarfed on the banks.) Lemna and Wolffia also occur, but like *Apium inundatum* they are probably importations, not being found out on the open uncultivated flats.

The abundance of Charophyta is a notable feature. There is much lime in the sandy Flats soil, and all the standing waters are more or less alkaline, even in higher areas where the surrounding surface soil may be so leached and mixed with humus as to give a neutral or slightly acid reaction. This is especially favourable to the growth of Chara, of which eight species are found, as well as *Tolypella glomerata* and three particularly beautiful large Nitellas (*N. praeclara*, *N. plumosa*, and *N. Dregeana*).

There is unfortunately not time to treat of the algae of the Flats in this brief survey, but one striking negative feature — the paucity of Desmids in an otherwise rich algal flora — may be mentioned here as correlated with this alkalinity. It does not seem to have any connection with the seasonal character of the waters, as might be supposed, as they are abundant in similar temporary waters on the Stellenbosch Flats, and common on seasonally-oozing wet spots and seasonally-dripping mosses on Table Mountain. But the water in all these cases is acid to neutral, never alkaline.

Passing mention should be made of the rich amphibian, crustacean and other animal life which adds variety and interest to these seasonal pools, and incidentally raises the same problem as the plants — what becomes of all this life in the dry season? For during September the rainfall is getting less, during October and November the temporary surface waters are gradually drying up, and by the end of the year all traces of aquatic life have vanished except for the shells of snails and crustacea and the lime-encrusted remains of Chara. Salicornia and Crassula emerge from their six months' submergence (endured with an apparent tranquillity that itself raises another problem), the grass sends out new shoots, and it is difficult to realise that a water-plant ever grew on the Flats.

The origin of the depressions in which these temporary waters collect is another point of interest. A few are obviously due to the removal of sand or stone (surface limestone or surface quartzite) for road-making and building, but the majority seem to have been caused by wind erosion. This can still be seen at work in many places, of which the most convenient for the visitor is the big dune whose advance threatens the roadway beside St. Joseph's Shrine. Standing on the top of this, one sees how its advancing crest has left in its wake a long and broad trough, which in the rainy season is quite a large vlei, gradually becoming colonised with water-plants. Most of the area which now forms the Flats was submerged till comparatively recent geological times, a sea-strait formerly separating the mainland from the present peninsula. It is now covered by a surface layer of blown sand, over clay-slate in the northern half and granite in the southern. Over most of the Flats this has become fixed by vegetation, but in former times when it was less fixed than now, the strong south-east winds of the dry summer must have scooped out many shallow hollows, and shifted many dunes, leaving depressions in their wake. These, now fixed by vegetation, form the present vleis and pools. Underlying clay, formed from the slate and granite, prevents water from percolating deep into the ground, so that after the sand has become soaked with the first rains it accumulates in every hollow.

Passing from Flats to mainland, we find that, area for area, the latter seems poorer in seasonal aquatic life. For although all the flowering plants mentioned above (except recent introductions) probably came thence to the Flats, and have all been found on the mainland by the writer, standing water is much less frequent, and is often turned by the farmer into a dam, with consequent damage to aquatic plants by trampling livestock. In respect of water Pteridophyta, however, the mainland is richer. *Marsilia macrocarpa* has been found at Philadelphia in the Cape Division, and at Worcester, and is quite frequent further east. Isoetes is represented by three species,* the *I. capensis* of the Cape Flats, which has been found at Somerset West and at Stellenbosch, and *I. stellenbossiensis* and *I. Stephansensii*, for both of which the only locality so far recorded is the Stellenbosch Flats. This fact emphasises the scantiness of our knowledge of the mainland vleis, and it is to be expected that further collecting will add considerably to the records of their aquatic vegetation.

(2) *Lagoons.*

There are only three of these in the Cape Division, all of which come under the heading of seasonal vleis, as they dry up annually like the streams which feed them. One of them, Zand Vlei at Muizenberg, is mainly freshwater; the other two, Riet Vlei at Milnerton and Allegemene

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*These are new (1929) species. *I. capensis* was collected in 1921 but put down as *I. natalensis* (Sim in South African Journal of Science, 1923); the other two are recent discoveries by Miss A. V. Duthie of the University of Stellenbosch, who has an account now in the press of all three and would be glad to receive further records of their occurrence. Though their leaves disappear as the dry season sets in, the root-stock with its decaying sporangia (the spores are distributed by earth-worms) may still be found about an inch below ground level.

Vlei at Kommetje, are brackish and their flora differs accordingly. Zand Vlei (Muizenberg Vlei, Lakeside Vlei) is fed by the waters of the Kayser's River and two smaller streams, which spread out behind the Muizenberg dunes to form the vlei. Before these cease running they have brought down such a quantity of water that the vlei is only completely dry by the end of summer, and if the summer is a cool one and the rains last late, it does not dry up entirely. According to the old maps the vlei was formerly much more open to the sea at its mouth, and even now, spring tides will flow in through the channel that is cut to the sea to keep the vlei water from flooding the farm lands around. The influence of this sea-connection is seen in the presence, in the eastern portion, of species of Ruppia and Zannichellia, characteristic plants of brackish water (though the latter may linger on in places which, like the Black River valley below Raapenburg, have now lost all connection with the sea). The plant life is otherwise of the characteristic seasonal-vlei type, *Potamogeton exiguus* being the dominant aquatic. It is interesting to note that the bulbous aquatics (Oxalis, Dipidax, Hypoxis) are absent, which may perhaps be correlated with the fact that the bottom does not dry out as completely as in the more temporary vleis. On the mountain side of the line the vlei merges into a Typha-Scirpus-Cyperus-Phragmites marsh.

Riet Vlei is a large lagoon formed by the Diep River (which rises near Malmesbury) spreading out in the flat land behind Tygerberg station, between the railway line and the coastal dunes. These dunes block up what was evidently once the sea mouth of the vlei, which has now an overflow-channel emptying into the Salt River at Milnerton. Evidence of the former sea-connection is seen in the abundance of Zannichellia and the absence, as far as the writer's investigations have gone, of purely fresh-water aquatics.

In Allegemene Vlei at Kommetje, Ruppia is dominant, the stream feeding the vlei being a small one and the influx of spring-tides frequent. The vlei consists chiefly of two shallow circular "pans" which in summer are white with dry Ruppia and the lime-encrusted remains of Chara.

(3) *Marshes.*

The marshes of the Cape Division are taken here under the head of seasonal waters, as although their characteristic plants (Typha, Scirpus, Cyperus, and often Phragmites) may persist through the dry season, the ground in which they stand is only flooded for six to nine months of the year. Otherwise they do not differ from those of other lands, and their chief interest lies in the seasonal aquatics which may occur in any open water still left in the marsh. Marshy places in the Cape Division are few and of comparatively small extent. A typical one lies between road and railway on the northern side of Zand Vlei, on which vlei the marsh is continually encroaching. In fact, much of the present marsh was open vlei in the writer's recollection, and only constant cutting has prevented the marsh vegetation from occupying all the vlei area west of the railway line.

(b) PERMANENT VLEIS.

The chief of the permanent vleis on the Cape Flats are Zeekoe, Ronde, and Princess, which are entitled to rank as lakes (although they shrink considerably during the dry season, and Ronde has even been known to dry up); and the smaller Little Princess and Lange in the valley of the Diep River. The aquatic life of these permanent vleis offers a total and surprising contrast to that of the temporary ones. The difference is mainly on the negative side, consisting in the absence of most of the plants and animals mentioned above as characteristic of the seasonal waters. On the positive side, fish occur in them, and blue waterlilies (Nymphaea) used to be found in the creek at the north end of Princess Vlei and are now (1929) being replanted there. Also the introduced *Eichornia crassipes* has within the last three years formed a dense covering over the whole of Lange Vlei, but is now being removed. In Zeekoe, a suspension of microscopic blue-greeens has recently become so dense that one cannot see more than three or four inches into the water during the dry season, and round its margin there are many irregular calcareous concretions due to the activities of the green alga Gongrosira. Otherwise, the plant life of these permanent vleis is singularly poor in comparison with the seasonal ones. This difference would seem at first sight to be an easy matter of greater alkalinity and salinity in the permanent waters, but this facile explanation does not work; in fact, some of the richest seasonal vleis are more alkaline.

One clue to these differences may perhaps be found in the fact that the margins of Princess and Lange Vleis produce a growth of typical seasonal life when annually flooded, though not in such variety as in the temporary vleis. But here again the obvious explanation of a difference in concentration of the water is countered by the problem of why Ronde Vlei, which is much more concentrated and saline than Zeekoe, has a richer plankton and a bottom covering of *Potamogeton exiguus* and *Chara* *fragilis*, the only non-planktonic plant-life in Zeekoe being a scant growth in several places of *Scirpus maritimus*, and the beginning of a marsh at the end of the long north arm. Yet Ronde and Zeekoe are connected when quite full by an overflow channel, and according to the old maps were once continuous. In fact, the whole question of the distribution of life in both permanent and temporary waters is much more complicated than it appears at first sight, and much observation and experiment are needed before one can venture to theorise on the subject.

Another problem concerns their origin, which seems to differ from that of the temporary vleis. The raising of the land in this area relative to sea level in recent geological times, which has been demonstrated by Dr. Shand, led to an obliteration of the Cape Strait (already referred to) by the deposition of a gradually-widening sandy isthmus, the Cape Flats, between Table Bay and False Bay. It is probable that the present lagoons and vleis represent the remains of larger ones formed on this widening isthmus where the drainage of the higher parts of the Peninsula entered the sea. Wind erosion and deposition has no doubt played an important part in modifying the form of the large vleis; this process may still be seen in operation on the northern shores of Zeekoe. It is interesting to note that maps of two centuries ago, made before the sands were covered with their present mantle of vegetation, show the vleis much larger and differing in shape from those of the present day. But soundings to find the depths of the vleis, and more knowledge of the geological history and physiography of the Flats, are necessary before going further than these cautious generalisations.

(c) STREAMS.

A glance at the map in Kipp's "Geography of the Cape Division" will show a dozen streams marked on it, nine of them on the Cape Peninsula. Besides these, there are overflow channels, often mere ditches, along which water runs from the higher to the lower vleis during the rainy season, and many other seasonal streamlets, especially on the mountain slopes. Of all these, the only permanently-flowing one is the Liesbeek River, and even it may be reduced to a mere trickle in the lower part of its course towards the end of the dry season. Several of the others are permanent in the upper part of their course, but usually have not sufficient volume to reach the sea in the late summer. The Black River below Raapenburg appears to be permanent, but this is due to a sewage effluent which now discharges into its canalised channel.

The Liesbeek used to spread out to form a chain of vleis and marshes at parts of its course from Rondebosch to Salt River, but it has been canalised for many years, with a resultant loss of interest. The rainy-season floods, sweeping down the channel now confining it, give no opportunity for water-plants to establish themselves. Of the other streams, the most interesting is one flowing down Orange Kloof, which in its lower reaches becomes the Hout Bay River. It contains Batrachospermum and other characteristic stream algae, and the beautiful *Nitella plumosa* grows in its quieter level reaches. Water-cress sometimes grows in the quiet lower parts of the more permanent streams, and *Scirpus flaccidifolius* is often present in the water-falls and rapids of their mountain courses. The rocks in their beds are often covered by mosses and foliose liverworts, but these can hardly be regarded as true aquatics, as the same species grow sub-aerially on dripping rock-ledges and similar damp situations. But there are two common lichens which may be regarded as typical of the temporary mountain streams, for they have never been found away from them, and do not seem to occur on constantly wet or constantly dry rocks. These are *Siphula tabularis*, which occurs as large whitish or greyish patches, and a Lecanora which makes green splashes on the submerged rocks of these seasonal mountain torrents.

Palmiet (*Prionium serratum P. palmitum* of Fl. Cap.) is found in several places in the Cape Division, notably in the Hout Bay and Zilvermyn Rivers on the Peninsula. But it never attains to the extensive development that is seen in the larger and more permanent streams of the mainland.

(d) RESERVOIRS.

There are five reservoirs on Table Mountain, the waters of which, like probably all the mountain waters of the south-west, are slightly acid. As might be expected from their elevated position and their comparatively recent construction (the oldest, the Woodhead, was first filled in 1897), their aquatic flora is planktonic only, and sparse at that. The plankton was studied in January 1928 by Hutchinson and Pickford, and the most interesting plant constituent of it was *Peridinium tabulatum*, common in the Woodhead reservoir. Peridinium has been found by the writer elsewhere in the Cape Peninsula, but appears to be absent from the alkaline Flats waters.

A reservoir with an interesting history is the large Paarde Vlei at De Beers explosive works, Somerset West, just over the border of the Cape division. This has been a permanent vlei as long as known, and in 1901 was much enlarged and made into a reservoir. It is very unfortunate that no reliable records exist of its plant-life previous to this, as the original flora was dug out with the bottom when the vlei was drained and deepened. At present it is filled by a water-lead from the Lourens River, which comes from the mountains near. Its water is in consequence neutral to slightly acid, and nine years ago desmids brought down by the water-lead flourished in it, in striking contrast to their paucity in the alkaline waters of the Cape Flats. Unfortunately, *Sphaerozosma aubertianum* flourished too abundantly, and its gelatinous coat caused trouble in the manufacture of explosives, the vlei water being used for the washing of gun-cotton; so that the writer was reluctantly compelled to suggest remedies which have had sad results from an algological standpoint. Desmids are numerous also in the large reservoir filled by the Steenbras River in the same range of mountains.

This account of the local aquatic flora gives only the barest outline of the subject. Enough has been said, however, to show what a wide field for investigation it presents, and in particular what a paradise for the aquatic biologist the Cape Flats are during the rainy season. The future of this paradise, however, gives occasion for some anxiety. Some of the vleis and pools near civilization have gone within the writer's memory, drained or filled in. For example, a vlei on Green Point common, often mentioned in plant records, has been drained, and the large triangle bounded by the main and Wynberg lines and the Liesbeek River, once a particularly happy hunting ground, now lies buried under several feet of city rubbish. Out on the open Flats drainage is a difficult proposition, though even here cultivation and the sinking of wells may lower the water-table so as to make adjoining vleis dry. But the sandy soil is good for vegetables, and much market produce is grown during the summer in areas that are flooded during the rains. This does not seem to interfere much with the resting spores and seeds (though the association of charophyta and cabbage-stalks is a curious one); but it is likely that many of these depressions will in time become filled in to allow year-round cultivation. There is thus real need to save some of the particularly interesting and accessible areas (such as Isoetes Vlei near St. Joseph's Shrine and the beautiful vlei near Crawford station) for the use and enjoyment of future generations of naturalists.

In conclusion, the writer would like to acknowledge a very special debt of gratitude to Mr. and Mrs. Hutchinson (G. E. Pickford), who in 1928 extended their pioneer work on the plankton of South African fresh-waters to the Table Mountain reservoirs and several of the vleis on the Cape Flats, and have most generously given permission to use their notes of the data obtained. (The full account of their results will be published shortly.) She has also much pleasure in acknowledging valuable assistance received from other friends. Mr. Stanley Lewis has kindly allowed his knowledge of the old maps of the Cape Peninsula to be drawn upon; Mr. Jack Rennie has supplied relevant geological literature and made valuable suggestions in the field; Captain Maurice Hallack has furnished useful information regarding the history of Paarde Vlei and the hydrogen-ion concentration of its waters; and to Mr. E. J. Steer the writer is much indebted for ten years' assistance in collecting the data embodied in this brief account of our local fresh-water vegetation.

Sea Weeds of the Cape Peninsula.

M. R. LEVYNS.

THE sea-weed flora of the Cape Peninsula offers rather a striking contrast with the Angiospermous one to any visitor from the northern hemisphere. Amongst the Angiosperms many families and a large number of genera will be new, whereas the sea-weeds are so similar that anyone acquainted with the sea-weeds of Europe will find little difficulty in placing most of the local representatives in their correct genera. The chief interest lies in the fact that the temperature of the water on the west coast is considerably lower than that on the east coast, and the floras on the two coasts are strikingly different.

The Cape Peninsula runs approximately north and south and possesses a coast-line varying in type with the nature of the rocks composing it. Sandstone and granite occur on both coasts, the latter having, wherever it occurs, rather a poor sea-weed flora. On the northern part of the west coast slates form the shore line. These are highly tilted and so rarely give rise to shallow pools suitable for plant growth. Sea-weeds are most abundant in the sandstone areas.

The two coasts offer many distinguishing features. The west coast is bathed by the cold waters of the Atlantic Drift Current, while the east coast is affected by the warm Mozambique Current. As might be expected in a region where two very different currents meet, there are considerable seasonable variations. In summer the maximum difference in temperature is reached, the winter temperatures being more uniform. The water on the east coast has a higher degree of salinity which may be a factor of ecological importance. Violent storms which occur at intervals throughout the winter months result in enormous breakers along the west coast, but such storms affect the east coast to a very small degree.

All these differences are reflected in the sea-weeds. Speaking generally the outstanding phycological character of the west coast is the number of large thalloid forms. *Ecklonia buccinalis* (the sea bamboo) is the most conspicuous of these, but certain others such as *Laminaria pallida*, *Macrocystis pyrifera* and *Desmarestia aculeata* amongst the Phaeophyceae, and *Iridaea capensis*, *Pachymenia carnosa*, *Schizymenia obovata* and many others amongst the Rhodophyceae, are of frequent occurrence. On the warmer east coast the sea-weeds are much smaller and the large thalloid forms are poorly developed. Few of the tropical forms which are present in the more easterly portion of South Africa have succeeded in establishing themselves on the Cape Peninsula. *Caulerpa ligulata* is the most outstanding of those which have succeeded in doing so, and it is confined to the False Bay coast.

The strong light of the summer months has a pronounced effect, especially on members of the Rhodophyceae. A large number of these show bleaching of their exposed portions, and reproduction practically ceases. As winter approaches a season of great reproductive activity is inaugurated. This slows down somewhat during the mid-winter months but increases once more in the spring. Intense light is probably responsible for another phenomenon. The

Rhodophyceae, unless living in deep water or under rock-ledges are usually brown in colour. This is somewhat disconcerting at first but a little practice soon distinguishes these from the true brown sea-weeds. *Hypnea spicifera*, a very common member of the Rhodophyceae, on the east coast, is bright green in its upper portions.

The sea-weeds present a field of research which has been barely touched. Probably no place in the world offers such wonderful scope for an ecological study of these plants.

The Fungous Flora of the Western Province of the Cape.

P. A. VAN DER BYL.

THIS brief review of the fungous flora of the Western Province of the Cape aims at giving a general representation of the families, genera and species of fungi represented in the area named. It stands to reason that space will not permit to capitulate all the species recorded. Neither will space permit me to refer to the various scientists who have contributed to our knowledge of the fungous flora of the area named.

I can, however, on this occasion, hardly resist the temptation of mentioning the name of one, who is regarded as the father of systematic mycology and who saw the light of day in Cape Town 168 years ago. I refer to Christiaan Hendrik Persoon, whose writings on mycology will ever remain as masterpieces in the annals of mycology. His father, Christiaan Daniel Persoon, was a Prussian who had settled in Cape Town and there married Elizabeth Wilhelmina Groenewald, the daughter of a Dutch citizen. Of this marriage, Christiaan Hendrik was the youngest of a family of two daughters and one son. In 1775, at the age of 12, young Christiaan was sent to Europe for his education and in the following year his father died at Cape Town. Young Christiaan never returned to South Africa though he appears to have kept up regular correspondence with his relatives here. He died at Paris in

1837. In 1924 Dr. Verwoerd published, from records preserved in the Cape archives, some interesting details of Persoon's early life and this appears to have aroused renewed interest in this South African scientist and student of early days. May the work of Persoon ever serve as an inspiration to younger South African mycologists and may a fitting tribute to his memory yet be erected at a South African University interested in the science of which he was one of the foremost pioneers.

BACTERIA.

The BACTERIA are usually not included in the fungi proper, but as several of them are responsible for more or less serious diseases in cultivated plants a brief reference to the species of economic importance in this respect in South Africa will not be misplaced in this review. The crown-gall disease caused by *Pseudomonas tumefaciens* is a serious pest in fruit trees. Infection evidently takes place principally in the nursery and such infected trees when planted out in the orchard usually grow well for the first year or two and thereafter show signs of ill-health and little vigour. There is no other alternative but to dig out and destroy trees in this state. Amongst other plants vines are also subject to crown-gall, but in general the disease on vines appears under South African conditions to have less serious results than on fruit trees. Other bacterial organisms causing diseases of cultivated plants in the Western Province are *Actinomyces chromogenes* (*scabies*) as the cause of brown scab on potato tubers; *Bacterium nectarophilum* which causes a blossom-blight on pear trees; *Bacillus citrimaculans* the cause of a spot disease on oranges; and *Bacterium maculicolum* the cause of a leaf-spot on cabbage and cauliflower plants.

MYXOMYCETES.

Of the MYXOMYCETES or Slime Moulds several genera and species occur in the Western Province. *Plasmodiophora Brassicae* may be a serious pest to cabbage growers in certain areas on the Cape Flats, in the Stellenbosch district and elsewhere. A few of the non-parasitic genera and species should be mentioned if only to indicate roughly the families represented in the Western Province. *Ceratiomyxa fruticulosa* is known from the Knysna forests. *Fuligo septica* is not uncommon on pine stumps in the vicinity of Cape Town, Stellenbosch, etc. *Leocarpus fragilis* occurs on fallen pine needles and *Badhamia utricularis* on dead wood. Several Physarum spp. are represented, e.g. *P. viride; P. melleum; P. compactum; P. pusillum; P. auriscalpum; P. flavicomum* and *P. vernum*. The genus *Stemonitis* is represented among others by *St. splendens* and *St. fusca*, and other members of the STEMONITACEAE are *Comatricha nigra, C. typhoides,* and *Lamproderma scintillans.* Of the RETICULARIACEAE, *Reticularia lycoperdon* has been collected on fallen pine needles at Stellenbosch, and *Dictydiaethalium plumbeum* on dead wood. Of the HETERODERMACEAE, *Cibraria intricata* and *Cib. argillacea* occur on pine stumps at Knysna and at Stellenbosch respectively and the genus Dictydium is represented by *D. cancellatum* from Stellenbosch. Of the ARCYRIACEAE, mention may be made of *Arcyria cinerea; Ar. denudata; Ar. nutans; Ar. Oerstedtii.* The family LYCOGALACEAE is represented by *Lycogala epidendrum* and *L. flavo-fuscum;* the family DIDYMIACEAE by *Didymium difforme* and *D. nigripes var. xanthopus.* Of the TRICHIACEAE, mention may be made of *Hemitrichia serpula,* and *H. clavata* occurring on old wood in the Knysna forests. To come now to the EUMYCETES or true fungi, we find the majority of the larger families represented to a greater or less extent in the Western Province.

PHYCOMYCETES.

Of the PHYCOMYCETES, *Empusa Muscae* is common on the house-fly, whereas *Rhizopus spp.* are common saprophytes. Of the plant pathogenes belonging to this class, mention should be made of the following: *Peronospora Schleidenii* which at times causes serious damage to the onion crop; *P. Mesembryanthemi* which attacks Mesembryanthemum spp. with serious consequences; the potato fungus, *Phytophthora infestans*, while not common in our potato fields, is yet no stranger; *Plasmopara viticola* is not known to occur in the vineyards of the Western Province, but is known from the Transvaal and the Eastern Province of the Cape; *Cystopus candidus* is at times abundant on *Raphanus raphanistrum*, the so-called " ramenas " or jointed charlock, and also on *Cochlearia armoracia*, the horse-radish; whereas *Cystopus tragopogonis* may cause serious damage to the Scorzonera crop.

ASCOMYCETES.

The ASCOMYCETES as a class are comparatively well-represented in the Western Province and it will be best to capitulate some of the genera and species under the families to which they belong.

Belonging to the EXOASCACEAE we find *Taphrina deformans* as the cause of leaf-curl on peach trees, whereas *Taphrina aurea* occurs on the Lombardy Poplar around Stellenbosch and at Constantia in the Cape Peninsula. Of the PEZIZALES we find *Pseudopeziza medicaginis* as the cause of leaf-spot of lucerne. It cannot be said that the saprophytic genera and species have thus far received much attention but incidentally the following have been noted from the Western Province: *Geopyxis ammophila*, a nice cup-fungus which grows in sandy soil around Hopefield; *Ascobolus stercorarius* and *Cheilymenia coprinaria* which grow on manure; *Eubelonis Ocoteae* found growing on the bark of *Ocotea bullata*, the so-called " stinkhout " tree; *Lachnea hemisphaerica* grows on the ground, whereas *Lachnea capensis* has been described growing on manure.

Of the HELVELLALES, mention may be made of *Morchella conica*, met with in oak plantations or growing between shrubs in the vicinity of Cape Town.

The only representative of the PHACIDIALES thus far known in the area dealt with is *Naemacyclus niveus* which is common on pine needles around Cape Town, Stellenbosch, and other localities.

Of the order HYSTERIALES, it should be mentioned that the several species of different genera which are parasitic on pine needles in Europe and America have as yet not found their way to South Africa.

The ASPERGILLACEAE is represented by the genera *Aspergillus* and *Penicillium*. *Aspergillus niger* may under certain conditions be responsible for the rotting of onion bulbs in storage, whereas *Penicillium digitatum* is the most common cause of the rotting of citrus fruit in storage.

Of the ERYSIPHACEAE or Powdery Mildews the following genera and species attacking economic plants in the Western Province may be mentioned; *Sphaerotheca pannosa* common on rose bushes and *S. Humulis* common on the cosmos plant. *Podosphaera leucotricha* is the cause of powdery mildew on apple trees and under certain conditions may be quite serious. The powdery mildew of the vine — *Uncinula spiralis* — is a disease known to probably all wine farmers in the Western Province and from all accounts it first made its appearance in the Cape during the years 1858-1859. The species thus far mentioned occur in South Africa only in their conidial condition and to the present their perithecial stage has not been recorded from this country. *Erysiphe graminis*, the cause of powdery mildew in oats and wheat, is one of the few representatives of this family to develop its perithecial stage under South African conditions. Other representatives of the genus *Erysiphe* in the Western Province are *E. Cichoracearum* which is specially troublesome on pumpkin plants, tobacco plants, etc., and *E. Polygoni* which occurs on peas. The oaks in the Western Province are seriously affected by a powdery mildew known only in its conidial stage and at present referred to *Oidium Quercinum*. *Leveillula taurica* occurs on *Tropaeolum spp.* in the Western Province.

Members of the family PERISPORIACEAE are especially met with on forest trees. In the natural forests at Knysna and surroundings the following are amongst those found: *Dimerium MacOwanianum* on *Putterlichia sp.*; *Irene scabra* on *Trichocladus crinitus; Irene Strophanthi* on *Gonioma kamassi*, the so-called "kamassiehout" tree; *Meliola falcata* on *Plectronia; M. ganglifera* on *Curtisia faginea*, the "asgaaihout" tree; *M. Hendeloti* on *Nuxia floribunda*, the "vlier"; *M. peltata* on *Podocarpus Thunbergii*, the true "geelhout"; *M. Rhois* on Rhus; *M. Zehneriae* on *Zehneria obtusiloba; M. Cluytiae* on *Cluytia pulchella; Phycopsis africana* on *Pterocelastrus variabilis; Pilene africana* on *Olea exasperata; Rizalia confusa* on *Olea capensis.*

Of the ENGLERULACEAE, mention may be made of *Diathrypton radians* on *Cunonia capensis*, the "rooi-els," in the Knysna forests; whereas *Parenglerula MacOwaniana* has been found on *Gymnosporia sp.* around Hopefield and its *var. Elaeodendri* on *Elaeodendron kraussianum* at Knysna.

Members of the families POLYSTOMELLACEAE and MICROTHYRIACEAE are also specially met with in the natural forests. As examples of the firstnamed family in the area dealt with, mention may be made of *Cycloschizon Brachylaenae* on *Cryptocarya angustifolia; MacOwaniella myrsinicola* on *Myrsine melanophleos; Hysterostoma capense* on *Olea exasperata; Hysterostoma Faureae* on *Faurea McNaughtonii*, the Terblanz or "boekenhout"; *Hysterostomina Eucleae* on *Euclea sp.;* and *Asterodothis solaris* on Elaeodendron sp.

Of the second family named above the following genera and species may be referred to: *Asterina delicata* on *Trimeria alnifolia; A. rhamnicola* on *Rhamnus prinoides; Asterinella disseliens* on *Elaeodendron croceum; Asterinella Burchelliae* on *Burchellia capensis; Asterinella Acocantherae; Echnoides rhoina* on *Rhus laevigata; Eupelte amicta* on *Olea laurifolia; Amazonia Goniomae; Morenoëlla Phillipsii* on *Ocotea bullata; Englerulaster Gymnosporiae; Englerulaster orbicularis* on *Ilex capensis*, the "waterhout" tree; and others.

Judging by the specimens thus far found the HYPOCREACEAE are but poorly represented in the area dealt with. At Knysna *Hypocrea incarnata* has been found on the bark of a tree and *Nectria peziza* on bark. In addition *Claviceps Paspali* is common on Paspalum grass wherever cultivated and an undetermined Claviceps sp. is at times very abundant on the grass *Pennisetum macrourum* around Stellenbosch.

The SPHAERIALES are relatively poorly represented by indigenous species in our area as the following review of the different families will indicate.

Belonging to the family CORYNELIACEAE we have *Corynelia uberata* on the leaves of *Podocarpus latifolia* and *P. elongata; Tripospora tripos* on the leaves of *P. elongata;* and *Corynelia carpophila* on the fruit of *Myrsine melanophloios.*

Of the family MYCOSPHAERELLACEAE mention may be made of *Mycosphaerella Byliana* on the leaves of *Olinia cymosa; M. brassicaecola* on the leaves of cauliflower; and *M. fragariae* the cause of leaf-spot on strawberry plants. Thus far the wine farmer of the Western Province has been saved from *Guignardia Bidwellii*, the cause of black rot of grapes in America and Europe, but it should be noted that this fungus was in 1911 also recorded from Pietermaritzburg in Natal.

Of the PLEOSPORACEAE we have represented *Physalospora Cliviae; Pyrenophora horrida* found on spathe valves of decaying grass at Stellenbosch; *Pleospora herbarum* on leaves of *Bilbergia sp.*, the genus *Venturia* is represented by *V. pirina* and *V. inaequalis* the cause of the so-called scab or fusicladium disease in pears and apples respectively and against which the fruit farmer has to take active steps to protect his crop. These two species are better known in their conidial or Fusicladium stage, in which stage they are parasitic. The ascigerous stage of these fungi develops on diseased leaves lying on the ground.

Members of the XYLARIACEAE are especially met with in the indigenous forests of the more sub-tropical region of the area dealt with, viz. the forests at Knysna and surroundings. *Daldinia concentrica* is a common saprophyte in the forests and Dr. J. Phillips found it on living *Halleria lucida;* of the genus Xylaria there are about 6 species and amongst them *X. tabacina*, *X. apiculata* and *X. reticulata.* The genus Hypoxylon (including the genera Nummularia and Ustulina) is represented by *H. punctulatum, H. clypeus; H. lepidum* recently described under *Nummularia* and found on rotting wood of *Gonioma kamassi.* In addition, mention may be made of *Kretschmaria micropus* and *Hypoxylon deustum* which is perhaps better known under the names *Ustulina vulgaris* and *Ustulina zonata.* In Ceylon and Java the last-named fungus is of economic importance in tea and in *Hevea* rubber plantations, but no authentic cases of it assuming a parasitic habit have thus far been reported from the Union.

Of the DOTHIDEALES the family *Dothideaceae* is represented by *Dothidea aloicola* on leaves of Aloe sp.; *Dothidina disciformis*, a common fungus on the leaves of Myrica sp. and *Perischizon oleifolium* on leaves of *Olea capensis.* Of the family PHYLLACHORACEAE, mention may be made of *Oligostroma maculiformis* on Protea sp.; *Thyriopsis Proteae* a new species found on leaves of *Protea scabra; Diplochorella amphimelaena* on the leaves of *Colpoon compressum* and described from South Africa by Montagne as early as 1843; *Gibbera Engleriana* on stems of Erica spp. and originally named *Dimerosporium Englerianum.*. The genus Phyllachora is represented in the area dealt with by *P. Melianthi* which is not uncommon on leaves of Melianthus sp.; *P. Penniseti*, usually abundant on leaves of *Pennisetum macrourum; P. myrsinicola* on leaves of *Myrsine melanophloios; P. Trifolii* on Trifolium sp.; and *P. Proteae* on leaves of *Protea mellifera*, the so-called "sugar-bush," and first collected in 1921 when it was named as above by Miss Wakefield (its description has not yet been published). Belonging to the family MONTAGNELLACEAE, mention should be made of *Montagnella maxima* which occurs on the leaves of *Aloe ferox* around Mosselbaai.

BASIDIOMYCETES.

We will next proceed to deal with the fungi belonging to the group BASIDIOMYCETES.

Of the USTILAGINALES or Smut Fungi, those affecting cereals are common, viz. *Tilletia Tritici*, *Tilletia laevis*, *Ustilago Tritici* and *Urocystis Triciti* on wheat; *Ustilago Jensenii* and *Ustilago nuda* on barley; *Ustilago Avenae* on oats. Dr. Verwoerd recently made a study of *Urocystis Tritici* and comes to the conclusion that this fungus was introduced into South Africa about 1915-1916. He also records *Urocystis occulta*, the cause of stem-smut of rye, from South Africa for the first time. Thus far we, however, know little about the distribution of this latter fungus in South Africa.

Of the smut fungi affecting plants other than cereals, mention may be made of *Entyloma physalidis* on *Physalis peruviana*, the "Cape Gooseberry"; *Ustilago Dregeana* which is common on *Cynodon dactylon; Ustilago bromivora* common on *Bromus unioloides; Ustilago Vaillantii* met with on Scilla sp.; *Tubercinia Eriospermi* which is at times exceedingly common on *Eriospermum pubescens* around Stellenbosch; and though not falling within the area dealt with I would like to mention *Ustilago Welwitschii* which occurs on that interesting West African plant *Welwitschia*

Bainesii. This last-named fungus was first described in 1899 and thereafter, evidently not again recorded until Mr. J. M. Krige collected it in 1929 on *Welwitschia* growing about 27 miles east of Swakop.

The UREDINALES or Rust Fungi are comparatively well represented. As examples of those belonging to the family MELAMPSORACEAE mention may be made of *Endophyllum MacOwani* common on *Rhamnus prinoides* in the forests around George-Knysna; *Melampsora Ricini* common on *Ricinus communis* wherever it grows; *Melampsora aecidioides* common on Populus spp. and in South Africa only known in its uredospore stage. Of the family *Pucciniaceae* the genera Uromyces, Puccinia, Phragmidium, Ravenalia and Kuhneola are represented and some of the species of these genera occurring in our area are mentioned below.

Of the genus Uromyces, *U. caryophyllinus* is frequently serious on carnation plants and *U. Fabae* on bean plants. Of species on indigenous plants mention may be made of: *U. Aloes,* frequent on Aloe sp.; *U. inaequialtis* on Silene sp. *U. Romouleae* on Romulea sp.; *Uromyces Albucae; U. badius* on Haemanthus sp.; *U. Bolusii* on Aspalathus sp.; *U. Eriospermi; U. Gladioli; U. transversalis* on Gladiolus and Tritonia spp.; *U. Zeyheri* on *Ixia maculata; U. Geissorhizae; U. Lachenaliae; U. Ixiae; U. Psoraleae; U. Rumicis; U. Peglerae* on *Digitaria sanguinalis; U. Polygoni; U. Ehrhartae-giganteae; U. stellenbossiensis* on *Urginea exuviata;* and others.

Of the species of the genus Puccinia attacking cultivated plants *P. graminis,* the cause of stem-rust or black rust of cereal plants, is probably the one of the greatest economic importance. The breeding of varieties of cereals resistant to this disease is a matter receiving the serious attention of the Departments of Plant Pathology and of Genetics of the College of Agriculture of the University of Stellenbosch and much interesting data have already been obtained. Our knowledge of the biologic strains of this rust occurring in South Africa is as yet very incomplete but this matter is also being studied by officers of the above-named institution and satisfactory progress has already been made. This institution, situated as it is on the borders of the cereal belt of the Union, and with two sub-stations in the cereal belt, is best suited to undertake work of this nature. Other Puccinia spp. attacking cultivated plants are: *P. Maydis*, the cause of brown rust of wheat and the aecidial stage of which develops on Oxalis sp.; *P. Chrysanthemi* on Chrysanthemum sp. in flower gardens; *P. pelargonii-zonalis* on cultivated Pelargoniums; *P. Pruni-spinosae* on the leaves of stone fruit trees. Of species on indigenous plants, mention may be made of *P. dispersa* on *Secale africanum* and the cause of the so-called " brown rust " of rye; *P. coronata* found on *Poa annua* and the same fungus is the cause of the so-called " crown rust " of oats; *P. bromina* on Bromus sp.; *P. torosa* on *Phragmites communis; P. Duthiei* on *Falkia repens; P. Drimiae; P. deformans* on *Montinia acris; P. malvacearum; P. Phragmitis; P. stellenboschiana* on *Ianthe aquatica, Ianthe flaccida* and *Pauridia hypoxidoides; P. Oenotherae; P. abutili; P. amadelpha* on Eucomis; *P. granularis* on indigenous Pelargonium sp.; *P. contecta* on *Bulbinella robusta; P. Ornithogali-thyrsoides* common on *Ornithogalum thyrsoides*, the so-called " chinkerichee "; *P. Hypochoeridis* which is frequently common; and others. The interesting genus Ravenalia is represented by *R. MacOwaniana* which in its aecidial stage developes conspicuous galls on the branches of *Acacia horrida* and is amongst others met with in the Karoo and in the districts of Oudtshoorn and Swellenddam.

Phragmidium disciflorum is common on rose trees and *Hamaspora longissima* met with on Rubus sp.; whereas *Kuehneola Fici* is the rust of the fig tree, and *Kuhneola albida* is met with on Rubus spp.

Of the *Uredinales Imperfecti* the genera Uredo and Aecidium deserve mention. Of the last-named genus the following species may be referred to: *Aecidium resinicolum* var. *tumefaciens* which develops conspicuous galls on the branches of *Rafnia angulata* and is commonly met with around Paarl and Stellenbosch and in the sand dunes between Hopefield and Vredenburg; *Aecidium Bylianum* common on *Senecio pinnulatus* but only recently described; *Aecidium Englerianum* on Clematis sp. in the Knysna forests; *Aecidium Elytroppapi* on *Elytroppapus rhinocerotis*, the common "rhenosterbos"; *Aecidium Viborgiae* was first described in 1898, but then evidently lost sight of until B. J. Dippenaar again colected it in the Tulbagh district in 1927. Of the Uredo spp. I would only mention *Uredo Disae* described from Knysna on *Disa micrantha.*

The family DACRYOMYCETACEAE is represented by *Dacryomyces deliquescens* which is relatively common and by *Guepinia spatularia* met with on old wood in the Knysna forests.

Of the family TREMELLACEAE mention may be made of *Exidia caespitosa; E. purpureo-cinerea* which is common; and of *Tremella fuciformis; T. microspora; T. crassa; T. lutescens;* and *T. mesenterica.* The Tremella spp. are specially met with in the indigenous forests.

The family AURICULARIACEAE is represented in our area by the cosmopolitan *Auricularia Auriculae-judae* on old wood and specially in our indigenous forests.

The family THELEPHORACEAE, whilst not abundant in our area, is represented by a few genera and species. *Cladoderris spongiosa* occurs on old wood in the Knysna forests. *Peniophora cinerea* has been found on branches of an old apple tree at Stellenbosch. *Sebacina africana* has recently been described from old logs in the Knysna forsests. Of the genus Stereum, the cosmopolitan *Stereum hirsutum* is a common saprophyte and occurs also as a wound parasite. The fructifications of *Stereum purpureum*, the fungus responsible for true silver leaf disease on peach trees, have thus far not been met with on fruit trees suffering from this disease, but has been found on old logs of willow, etc. Other Stereum spp. met with in the indigenous forests are *S. cinerascens; S. fasciatum; S. Schomburgkii;* and others. Of the other genera of the THELEPHORACEAE, *Coniophora atrocinerea* has been found on old stumps of pine trees at Stellenbosch; *Corticium pelliculare* on old wood in the Knysna forests; *Aleurodiscus acerinus var. longisporus* and *A. cerussatus* are on old wood in the Knysna forests, whereas *A. disciformis* has been found on the bark of a Podocarpus tree at Stellenbosch. *Thelephora intybacea* is common in pine plantations in the Western Province, and some years back, *T. penicillata* was described growing on pine needles at Stellenbosch. *Cyphella alboviolascens* occurs as a saprophyte on decaying branches and *Hypochnus Eylesii* grows on the ground at Stellenbosch.

The family CLAVARIACEAE is poorly represented in our area and mention may be made of *Clavaria pulchra* growing between grass and at times common at Stellenbosch and in the Peninsula, whereas *C. cyanocephala* has been collected in the forests at Knysna.

The family HYDNACEAE is also evidently very poorly represented in our area and I will mention *Irpex fusco-violaceus* and *I. vellereus; Hydnum longospinosum;* and a *Hydnum sp.* near to, if not identical with, *H. coralloides* and met with in the Knysna forests; *Grammothele mappa;* and *Lopharia mirabilis.*

The family POLYPORACEAE is comparatively well-represented, but only a few members will be referred to. *Polyporus sulphureus* is the cause of decay of our historic and treasured old oak trees. *Polyporus versicolor*, whilst a common saprophyte, occurs at times as a wound parasite on fruit trees. Other Polyporus spp. met with are: *P. arcularius; P. australiensis; P. conchoides; P. gilvus; P. lucidus;* the interesting *P. pocula; P. occidentalis; P. adustus; P. meleagris; P. ostreiformis; P. Telfairii; P. adustus; P. conchatus; P. Schreuderi;* and others.

Of the genus Fomes the following may be mentioned: the cosmopolitan *F. applanatus* which is a saprophyte on old wood in forests, but also attacks certain forest trees; *F. rimosus* which is parasitic on certain forest trees; *F. geotropus* found as a parasite on *Ocotea bullata*, the " stinkhout " tree; *F. Yucatanensis* on *Curtisea faginea*, the " *asgaaihout* " tree; *F. Robinsoniae* on *Gonioma kamassi;* and others.

Of the genus Lenzites we find *L. betulina, L. trabea,* and *L. repanda* as more or less common saprophytes in forests and plantations. The genus Daedalia is represented by *D. ligneotexta* and *D. quercina;* the genus Laschia by *L. rubella;* the genus Trametes by *Tr. Hystrix* and

Tr. salebrosa; the genus Hexagona by *H. albida;* the genus Fistulina by *F. africana*, a species growing on *Platylophus trifoliatus* in the Knysna forests and only recently described. Of the genus Boletus, mention should be made of *B. edulis* and *B. bovinus* which are common in pine plantations and of *B. stellenbossiensis*, a species recently described.

The family AGARICACEAE has received little attention from South African mycologists and our knowledge of the genera and species occurring in the Western Province is scanty and uncertain. The poisonous *Amanita muscaria*, *A. phalloides*, and *A. pantherina* are especially met with in pine plantations and deaths by eating these poisonous fungi occur from time to time. The cosmopolitan and edible *Psalliota campestris* is met with in our area. Several species of Coprinus are represented, including *Coprinus comatus*. *Lactarius deliciosus* is common in certain areas and *Laccaria laccata* and *Lepiota procera* are also met with. The cosmopolitan *Schizophyllum commune* is a common saprophyte and occurs at times as a wound parasite. The genus Lentinus is represented in the Knysna forests by *L. lecomtei*, the recently described *L. Phillipsii* and by *L. sajor-caju*. They all grow on old wood and the last frequently reaches large dimensions. *Lentinus lepideus* has been collected growing on pine stumps in the Paarl district.

GASTEROMYCETES.

As a class, the GASTEROMYCETES are comparatively well represented in our area.

Of the family PHALLACEAE, *Lysurus MacOwani* is at times exceedingly common on lawns in certain localities, whereas *Anthurus Woodii* and a *Phallus sp.* are met with in the Knysna area and two *Phallus spp.* in the Peninsula. *Kalchbrennera corallocephala* is evidently of a more eastern habitat and occurs around Grahamstown and at Durban in Natal.

Of the HYMENOGASTRACEAE, mention may be made of *Protubera africana; Hysterangium niger; Octaviana africana* and *O. carnea; Rhizopogon rubescens, R. capensis* and *R. luteolus;* and of *Hymenogaster lilacinus.*

The family TULOSTOMATACEAE is represented by *Tulostoma purpusii; T. mammosum; T. cyclophorum; Battarea phalloides;* and *Phellorina inquinans,* the so-called "ajoosie," whereas of the PODAXACEAE, mention should be made of *Podaxon carcinomalis,* the so-called "kraaisnuif," which grows only on termite heaps and is of historic interest for it was described by Linnaeus as early as 1781 from a collection by Thunberg, the father of South African Botany.

Belonging to the SCLERODERMATACEAE, the following deserve mention: *Polysaccum crassipes* which grows under Eucalyptus trees and it is an interesting speculation as to whether it is indigenous or introduced from Australia; *Scleroderma flavidum; S. vulgare; S. cepa; S. verrucosum; S. tenerum;* and of the genus Arachnion, *A. album; A. giganteum;* and *A. scleroderma.*

Coming to the LYCOPERDACEAE, we find the following representatives in our area: *Geaster striatulus; G. floriformis; G. saccatus; G. coronatus; G. Hieronymii; G. plicatus; G. pectinatus; Myriostoma coliformis; Lanopila capensis; Mycenastrum corium; Catastoma magnum; C. Zeyheri; C. pedicellatum; C. Duthiei; Bovistella oblongispora* and *B. aspera; Lycoperdon umbrinum; L. pusillum; L. cepaeforme; L. praetense; L. adjurense; L. oblongisporum; Calvatia lilacina;* and others. Of the family NIDULARIACEAE, the following may be mentioned: *Cyathus*

Montagnei; C. Berkeleyanus; C. Poeppigii; C. pallidus; C. vernicosus; and *C. microsporus.*

FUNGI IMPERFECTI.

In conclusion the FUNGI IMPERFECTI must be mentioned. Of this group our knowledge is as yet rather scanty and for the greater part limited to species attacking economic plants.

Belonging to the family SPHAERIOIDACEAE, mention may be made of the following: *Macrophomina limbalis* on leaves of *Sideroxylon inerme; Cytospora leucostoma* the cause of die-back of branches of the apple tree; *Fusicoccum africanum* on branches of the apple tree; *Ascochyta Pisi* attacking pea plants; *Sphaeropsis malorum* on apples and quinces; *Coniothyrum insigne* on *Ocotea bullata; Epistigme nidulans* on *Rhus spp.; Actinonema Rosae* the cause of leaf-spot on rose plants and of which the ascus stage is as yet unknown in South Africa; *Diplodia Pinea* on *Pinus insignis; Hendersonia Osteospermi* a species found on the leaves of an *Osteospermum sp.* in the Knysna district and named as above by Miss Wakefield though its description has not yet been published; several Septoria spp. and amongst them *S. Rubi; S. Helianthi; S. Dianthi; S. Antirrhini; S. Pelargonii; S. Lycopersici; S. Ranunculacearum; S. Chenopodii; S. Petroselini* var. *Apii; S. Byliana* on *Gunnera perpensa; S. myriotheca* on *Bubon galbanum;* and *S. Cotyledonis* a species described by Miss Wakefield on *Cotyledon orbicularis,* but of which the description has not yet been published.

The EXCIPULACEAE is represented by *Oncospora bullata* a fungus common on Scutia spp. in the Knysna district, and the LEPTOSTROMATACEAE by *Entomosporium maculatum,* the cause of leaf-spot and fruit-freckle of the quince.

Of the MELANCONIACEAE, I would mention *Gloeosporium ampelophagum*, the cause of the so-called anthracnose or swart-" roes " disease in vines and which is serious on certain varieties; *Colletotrichum Pterocelastri* collected at Knysna on *Pterocelastrus variabilis* and named by Miss Wakefield though its description has not yet been published; *Marssonia Populi*, the cause of a leaf-spot on *Populus sp.* and quite common; *Septogloeum arachidis* the cause of a leaf-spot on pea-nut plants and which may be serious especially in more tropical regions where peanuts are grown commercially; and *Septogloeum Mori* which causes leaf-spot on mulberry trees.

Of the MONIALES met with in the area dealt with, the following might be mentioned: *Botrytis cinerea* on grapes; *Periconiella velutina* frequently met with on the leaves of *Brabejum stellatifolium*, the " wilde amandel," at Stellenbosch; Cladosporium spp.; *Macrosporium Martindalei* on leaves of Magnolia sp. at Hopefield; *M. commune* on leaves of Syringa sp.; *M. tabacinum* on tobacco leaves; *M. Solani* the cause of " Early Blight " or " warmwatersiekte " of potato plants and which is frequently serious; *Cercospora circumscissa* the cause of leaf-spot of almond trees; C. *Myrti* on cultivated Myrtus sp. at Hopefield; C. *Resedae* on the cultivated *Reseda odorata*, the mignonette, at Hopefield; *C. beticola* on *Beta vulgaris*, the beet root; *Stilbum cinnabarinum* a saprophyte on old wood; an Isaria sp. on the Eucalyptus snout beetle (*Gonipterus scutellatus*) ; Fusarium sp. causing dry rot of potato tubers in storage; *Bactridium flavum* on old wood in the Knysna forests; and *Speggazinia Meliolae* on the leaves of *Olea foveolata.*

Of fungi of which the fructifications are unknown in South Africa, mention should be made of *Rhizoctonia Solani*, the cause of surface scurf of potato tubers.

Economic Plants in the S.W. Cape Province.

R. H. COMPTON.

THE plant husbandry of the South-West Cape depends on factors of soil and rainfall. The Table Mountain Sandstone which composes the chief mountain ranges yields a poor acid soil seldom cultivated (except at Piquetberg). The use of this type of country for grazing purposes leads to the flagrant evil of veld burning, which seriously impairs the prime value of the mountains as water catchment areas.

The heavier soils derived from the Malmesbury beds and to a lesser extent the granite soils are used for cereal crops of which wheat and oats are the chief. Ploughing is usually in May, and the crop is harvested before the heat of summer: the land lies under stubble in summer. No rotation of crops is practised and regular use of fertilisers is essential.

On alluvial and granite soils large numbers of fruit trees are grown. Grapes for dessert and wine are the most important crop. Peaches, Apricots, Pears and Quinces are also largely grown. Apples come to perfection on Bokkeveld beds in the Elgin and Ceres districts.

Oranges, Lemons, Grape Fruit and Naartjes are grown in localities where temperatures are high and summer irrigation is available, e.g. near Clanwilliam, and the valleys under the Drakenstein and Langeberg Ranges.

The climate is not suitable for Pineapples, Pawpaws, Avocados or Bananas: but the cucurbitaceous fruits, Sweet Melons, Watermelons, Pumpkins and Marrows, are a prolific summer crop in selected localities. Of the small fruits only Strawberries and Loganberries are grown near Stellenbosch, Raspberries, Gooseberries and Currants not succeeding.

Vegetable growing is in the hands of small market gardeners, and the sandy deposits of the Cape Flats, etc. provide good areas of "summer ground" and "winter ground" for this purpose. Cabbages, Cauliflowers, Tomatoes, Lettuces, Spinach, Carrots, Turnips, Beetroot, Peas, Beans, Potatoes and Onions are grown in abundance for the Cape Town market, a limited range of selected local varieties being used, e.g. the Cape Spitzkool Cabbage, the Cape Straw Onion, etc.

Other crops of the Cape area include Tobacco in the French Hoek and Stellenbosch districts, Buchu at Piquetberg, etc. There are several nursery establishments providing a fair range of plants and seeds for home gardens. Flower growing for market is a small industry, Chrysanthemums, Dahlias, Asters and Narcissus being the chief products: but a great part of the flowers sold is gathered wild to the serious prejudice and destruction of the most beautiful species.

Timber plantations are numerous where rainfall permits, the chief trees being *Pinus insignis*, *P. pinaster* and several species of Eucalyptus which make remarkably fast growth. The Forest Department has large plantations in the Cape Peninsula, near Wolseley, in the Cederbergen and at Elgin; and some fruit growers are also raising *Pinus insignis* for fruit boxes. A very large number of other exotic trees grow successfully as can be seen in such gardens as The

Hill at Claremont, the Cape Town Municipal Gardens, Fernwood House and the Tokai Arboretum: *Quercus robur, Pinus pinea, Araucaria excelsa, Eucalyptus ficifolia* being among the most frequently planted ornamental species.

The district is a very favourable one for home gardens of flowers, fruit and vegetables, but adequate description is impossible in the space available.

The Karoo areas are only suitable for the cultivation of crops in a few favoured localities where irrigation water is available. Occasional crops of winter Wheat are, however, raised in the Pietermeintjes district. The Karoo soils are usually rich and sweet, and where water can be led from mountain streams heavy crops of Lucerne, Sultanas, Grapes, Potatoes, etc. can be obtained.

Indigenous Economic Plants.

Buchu is gathered wild in the Cape mountains, and consists of the dried leaves of many Rutaceae, two of which, viz. *Barosma betulina* and *B. crenulata*, are on the regular markets. The former ("round-leaf") is obtained from the Cederberg, the latter ("oval-leaf") in the Drakenstein and neighbouring ranges. Cultivation now supplements the wild product.

Bush Teas. A large number of shrubs, mainly Leguminosae and Compositae, are used locally for infusion as beverages, and some have a more extended sale, namely *Aspalathus cedarbergensis* ("rooi bos") from the Cederberg, and *Cyclopia Vogelii* ("honey tea") from the Langeberg.

Berry Wax. The berries of *Myrica cordifolia*, an abundant sea-shore and sand-dune shrub, are the source of a hard wax used in the manufacture of polishes.

Timber. Several of the trees yield good woods for building and cabinet work, e.g. *Podocarpus Thunbergii* (yellow wood), *Ocotea bullata* (stinkwood), *Widdringtonia juniperoides* (Clanwilliam Cedar). The forests are small, however, and over-exploited in the past, and there is now no appreciable industry in the district.

Firewood. Many of the indigenous shrubs of mountain land, especially Proteaceae, are used locally for firewood. The method is employed of setting fire to the whole vegetation in order to kill the shrubs — a process destructive to flora, scenery and water supply.

Wild Flowers. The trade in these is considerable: very few of the indigenous species are cultivated, most of the Ericas, Gladiolus, Nerines, Disas, etc. being gathered wild. Many of the more attractive species are accordingly becoming extinct. A few plants of the S. W. Cape Province are commonly employed in gardens, both locally and in other countries with a similar climate. The Cape bulbs, Nemesias, Pelargonium, Mesembryeae, Amaryllis, Nerine, and a number of Compositae are in frequent cultivation and a large number of species are suitable for this purpose, but are not generally available.

Other Economic Plants. A large number of indigenous plants are used locally as sources of medicine, and some have a considerable vogue though experimental proof of their reputed virtues is deficient. *Dodonea Thunbergiana, Artemisia afra, Chironia baccifera, Peucedanum Galbanum, Melianthus major, Tulbaghia alliacea, Sutherlandia frutescens* are among the most generally used by country folk. Other plants are occasionally sought as food, e.g. *Aponogeton distachyum, Fockea Comaru, Morea edulis, Gethyllis spiralis, Carpobrotus acinaciformis, Brabeium stellatifolium.*

The National Botanic Gardens of South Africa

R. H. COMPTON.

No account of the botanical features of the South-West Cape Province would be complete without reference to the National Botanic Gardens, namely Kirstenbosch in the Cape Peninsula and the Karoo Garden at Whitehill. Both of these Gardens have two botanical aspects: firstly they both include excellent examples of the typical vegetation of their districts preserved as far as may be from destructive factors due to civilisation; and secondly they contain large collections of indigenous plants from other parts of the South-Western areas (as well as from the Union generally), labelled and registered and available for scientific study. Kirstenbosch is readily accessible from Cape Town, and is constantly visited by botanists, University students and nature-study classes from schools. Whitehill is 198 miles from Cape Town on the main railway line to the north.

KIRSTENBOSCH.

Kirstenbosch occupies a large part of the eastward slopes of Table Mountain. Its area is nominally about 1,100 acres, and its altitude ranges from 300 to 3,500 ft. above sea level. The rainfall averages about 57 inches per annum, the greater part of which falls during the winter months (May to September). The summer months are dry, but an inch or two of rain falls every month from December to March. Frosts do not occur at the lower altitudes, and are not severe at higher elevations. The temperature rarely falls below 40°F. or rises above 90° F. The soil is derived partly from granite and Malmesbury beds (on the Wynberg Ridge), partly from sandstone rubble (over the greater part of the area below 1,000 feet), and partly direct from the Table Mountain Sandstone (above 1,000 feet); and there also exist alluvial and vlei deposits.*

Uncultivated area.

The indigenous vegetation of Kirstenbosch and the Upper Kirstenbosch Nature Reserve includes several plant formations, the two most important being Forest and Scrub. From the point of view of geographical distribution the broad-leaved evergreen forest formation is an outlier of the forests found over larger areas in the Knysna and Humansdorp divisions, and is linked floristically with the forests of the Drakensberg and Central Africa. The other plant associations, here lumped together as scrub, are floristically composed mainly of "Cape" elements, whose affinities are rather with the circumantarctic region than with the remainder of Africa.

Forest. The broad-leaved evergreen forest occupies the walls of the steep gorges, especially in Skeleton Gorge, and tends to extend over more open slopes in situations where it has escaped burning and the axe. There are signs that under protection it is extending its area at the expense of the scrub associations.

The forest includes many species of trees,† all except the rare *Celtis Kraussiana* being evergreen, the typical leaf-form being simple, ovate, dark green, coriaceous and glabrous. *Olea laurifolia, Curtisia faginea, Podocarpus Thunbergii, Ocotea bullata, Kiggelaria africana, Rapanea melanophloios* and *Gymnosporia acuminata* are the most frequent species, but their relative abundance has not been estimated. *Cunonia capensis* and *Ilex capensis* are frequent along streams. The marginal association of trees and tree-shrubs includes *Rhus tomentosa, Polygala myrtifolia, Cluytia pulchella, Podalyria calyptrata, Grewia occidentalis* and *Virgilia capensis;* and this acts as a fore-runner association in the spread of forest and in regeneration in clearings. The forest undergrowth is scanty, including *Royena lucida* and *Scolopia Mundii* as shrubs, numerous ferns,* of which the arborescent *Hemitelia capensis* is conspicuous, a few herbaceous plants such as *Sanicula europaea, Leidesia capensis, Oxalis incarnata* (greatly increased where deciduous oaks relace indigenous forest), *Knowltonia vesicatoria* and *Schoenoxiphium capense*, and many Bryophyta. As lianes occur *Vitis capensis, Secamone Alpini* and *Asparagus aethiopicus.*

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*See A. R. E. Walker "The Geology of Kirstenbosch", Journ. Bot. Soc. S.A., VII, p. 5, 1921.

†See L. Bolus "The Native Trees and Tree-shrubs of Kirstenbosch". Journ. Bot. Soc. S.A. IX, p. 7, 1923.

Forest disappears above about 2,000 feet though stunted trees of Podocarpus, etc. occur above this altitude.

Scrub. The scrub associations of open slopes are very rich in genera and species, and consist of a complex mixture of plant forms. Shrubs form the top layer but no single species dominates, except in the striking case of *Leucadendron argenteum*, an aberrant member of the Proteaceae, which has adopted a tree habit of growth and forms the celebrated Silver Tree woodlands, whose relationship is rather with the scrub than with the forest. The Proteaceae are conspicuous, *Protea incompta* and *P. grandiflora* at low altitudes, *P. cynaroides, P. speciosa* and *Leucospermum conocarpum* between 1,000 and 2,500 feet, while shrubby Leucadendron spp. are abundant everywhere. The Ericaceae* are represented in Kirstenbosch by about 40 species, *Erica nudiflora, E. hirtiflora* and *E. hispidula* being extremely plentiful. Species of Rhus are abundant at low altitudes, and several species of Aspalathus form conspicuous, though often temporary, aspects after fires. Several Rutaceae, species of Pelargonium, Anthospermum, Cliffortia, Selago, Salvia, Struthiola, Agathelpis, and *Penaea mucronata* are conspicuous elements of the woody flora, and the list could be extended very largely. In the herbaceous flora Monocotyledons are abundant. Grasses are represented by about 40 species, but only *Ehrharta aphylla, Eragrostis curvula, Andropogon marginatus* and species of Pentachistis make any display. Restionaceae are frequent, and among the Cyperaceae species of Tetraria and Ficinia are abundant. Among petaloid Monocotyledons the tall *Watsonia rosea, W. tabularis, Aristea capitata* and *Bobartia gladiata* are conspicuous, and there are a large number of other species belonging to the Iridaceae, Liliaceae, Amaryllidaceae, Haemodoraceae and Orchidaceae. Among the Dicotyledons we find herbaceous species of Lobelia, Dimorphotheca, Arctotis, Senecio, Sutera, Wahlenbergia, tuberous-rooted Umbelliferae and geophytes such as many species of Oxalis and Cyphia. Succulents are represented by several species of Mesembryeae, Crassula and Rochea. Insectivorous plants include three or four Drosera spp., and among parasitic plants we find species of Thesium and Thesidium, *Hyobanche sanguinea*, *Harveya capensis*, *H. purpurea* and *H. Bolusii.*

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*See R. H. Compton "The Ferns of Kirstenbosch," Journ. Bot. Soc. S.A. X, p. 19, 1924.

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*See R. H. Compton "The Heaths of the Cape Peninsula, with Notes on Kirstenbosch Heaths." Journ. Bot. Soc. S.A. XI, p. 10, 1925.

As in all scrub areas in the Cape Province, the formation has no definiteness or finality, owing to the relatively short time elapsing between successive bush fires. It is difficult to speculate as to the destiny of the scrub in the absence of burning and other interference. In some spots, however, it would probably be colonised by broad-leaved forest; in others such tall shrubs as *Protea grandiflora* and *P. incompta* might attain dominance; and at the lower altitudes on soils derived from granite *Leucadendron argenteum* would form a tree layer with many scrub species beneath. The effect of fires, however, is to keep the vegetation low and to favour geophytes and rhizomatous plants at the expense of the hard-wooded shrubs.

Cultivated area.

The cultivated area in Kirstenbosch is laid out partly according to systematic affinities; thus there are separate gardens for the Proteaceae, Ericaceae, Compositae, Geraniaceae, Gymnospermae and Filicineae. On the other hand, cultural considerations have in some cases resulted in a more ecological arrangement, so that plants requiring summer moisture are mostly placed in the Dell, succulents in a special Succulent Garden, and so on.

Systematic work on the indigenous flora is carried on by co-operation between the Gardens and the Bolus Herbarium. Thus there exists at Kirstenbosch an unrivalled collection of plant material, both living and preserved, available for study and research.

Work on the cultivation, distillation, etc. of plants of known or reputed economic value, both indigenous and exotic, is also carried on at Kirstenbosch; and a large collection of such plants, principally medicinal and aromatic, is available for study and distribution.

WHITEHILL.

The Karoo Garden, Whitehill, lies in the Western Karoo at an altitude of about 3,000 feet. The average rainfall is probably about 6 inches annually. The rock formation is Dwyka Conglomerate with quartzitic inclusions. The garden has an area of 40 acres, of which about one-third is regarded as a Nature Reserve and protected from grazing and planting.

The indigenous flora is singularly rich, and may be regarded as a good sample of that of the Western Karoo (see p. 49). The exclusion of grazing animals from the Garden is allowing the vegetation to grow, flower and regenerate in a way that is impossible in the grazed area outside the fence; and the study of the flora is thereby facilitated.

The cultivated area is divided into sections on a geographical basis — e.g. Little Karoo, South-West Africa, Hex River district, and so on. The succulent flora is chiefly dealt with, this being planted out according to districts. Owing to the smaller rainfall and other factors, the succulent plants of arid localities are of simpler culture and display less modification at Whitehill than at Kirstenbosch. The Karoo Garden is under the same control as Kirstenbosch and also works in co-operation with the Bolus Herbarium for purposes of systematic research.

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